1988

Retention of content material as a function of mode of presentation and preconceived degree of difficulty : a thesis ...

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Retention of Content Material as a Function of Mode of Presentation and Preconceived Degree of Difficulty

A Thesis Presented to
the Faculty of the Graduate School
University of the Pacific

In Partial Fulfillment
of the Requirements for the Degree
Master of Arts

by
Richard S. Velayo
December 1988

This thesis, written and submitted by

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is approved for recommendation to the Committee on Graduate Studies, University of the Pacific.

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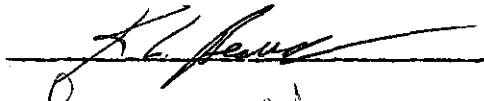
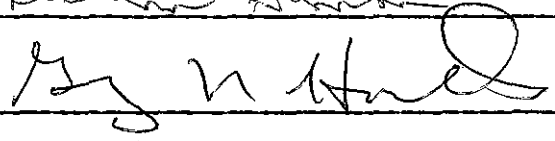
 Chairman



Dated November 1988

Acknowledgements

I would like to express my sincerest thanks to the following people:

To my thesis chairperson, Dr. Ken Beauchamp, whose expertise, kindness, and support were always there to help me get through the grueling process of doing this research and, in many ways, influenced my career goals;

To my academic advisor, Dr. Roseann Hannon, whose belief in my potentials has given me the motivation to work hard and be at my best;

To my "pal" and "buddy," Dr. Gary Howells, who continually nagged me to exercise and eat right but, nonetheless, made me feel special around the department;

To the other faculty of the Psychology department, Dr. Gipson, Dr. Cohen, Dr. Katz, and Dr. Matheson, all of whom made me feel at home in the 2 years I spent at UOP and made me realize more the value of my education;

To my dependable research assistants, Andy Cloutier and Tami Elkins, without whose help, this thesis would not have been finished on time;

To my friends and colleagues (Kerren, Sheri, David C., Shiro, Monica, David W-J, Linda S., Linda R., Lisa, Cathy, Steve, Jill, Teri, Connie, Kay, Dorothy, Wayne, Carolyn, and Joy), whose support and friendship made my life as a graduate student more bearable;

To my proud dad, Rudy R. Velayo, who gave me the much needed monetary and emotional support; and above all;

To myself (of course!) who worked relentlessly through those late nights in the department and in the computer lab to get this thesis finally done.

Abstract

The effects of the mode of presentation and the preconceived degree of difficulty on the retention of academic content material were measured. The design of the experiment was a 6 x 3 x 2 split-plot factorial. The levels for the mode of presentation were: (a) print-only, (b) pictorial-plus-print, (c) audio-only, (d) pictorial-plus-audio, (e) print-plus-audio, and (f) pictorial-plus-print-plus-audio. The levels for the preconceived degree of difficulty were: (a) very easy, (b) neutral, and (c) very difficult. The participants were 112 undergraduate students (24 males, 88 females) randomly assigned to the experimental conditions. The dependent variables were the immediate and delayed retention of content material measured through the use of four criterion tests: a drawing test, an identification test, a terminology test, and a comprehension test. Results for the univariate split-plot ANOVA of the total scores showed that the main effects of mode and preconceived degree of difficulty were found to be significant. All four predicted differences between means were not statistically significant. Only one of the three

hypotheses of no significant difference was supported--the hypothesis of no significant difference between the pictorial-plus-print-plus-audio condition and the pictorial-plus-audio condition. No significant mean differences between the easy, neutral, and difficult conditions were found, although there was a significant main effect and the means for these conditions were ordered such that the more difficult the content material was perceived, the lesser was the ability to retain such material. Multivariate analysis of the immediate and delayed tests showed that the major factors contributing to the significant effect of mode were the drawing and identification tests, but subsequent multiple comparison tests did not show significant support for any predictions. For the identification test, a significant main effect for mode showed that the pictorial-plus-audio and pictorial-plus-print-plus-audio means were significantly superior to the audio-only mean.

Retention of Content Material as a Function of Mode of Presentation and Preconceived Degree of Difficulty

Central to all intellectual functions is our capacity for memory. Memory plays a very important part in the way we function and, more specifically, the way we learn. In the present study, I measured the effects of the mode of presentation of information and the preconceived degree of difficulty on the immediate and delayed retention of content material.

When psychologists study memory, they first examine all of its three major components (i.e., encoding, storage, and retrieval) and then focus more on the storage component which is also referred to in this study as "retention." For instance, if we examine the studying behavior of college students and the rate at which they learn and store information, then we are concerned primarily with acquisition or learning. However, if we focus on what happens to that stored information after the students have studied, then we are concerned primarily with retention or memory. To study learning means to study retention

as well. In fact, the only way we can test to see if learning has occurred is to test for retention of the material in question (Houston, Bee, Hatfield, & Rimm, 1981). This study, though dealing with both learning and retention, focused on the retention of information.

A common criticism of current educational practices involves the lack of effective instructional methods to facilitate memory improvement (Klatzky, 1975). Fundamental to this problem is the universal assumption that students will learn simply because they are asked, or told, to learn or because we supply them with one of the increasing number of technological devices or supports available. We instead need to learn more about how to facilitate a person's ability to develop and use effective and efficient memory strategies. Although it is true that many of us acquire effective memorization skills as a function of our individual experiences, there still is a need to study and systematize these skills.

The present study dealt with the immediate and delayed retention of content material as a function

of two variables, the mode of presentation of instructional material and the student's preconception of the degree of difficulty of the material to be memorized. In the following sections, research on each of these variables has been reviewed. However, since I could find no research study that specifically took into account both variables, the following discussion of the literature is divided into three main sections: (1) studies on learning and memory as a function of the mode of presentation of content material, (2) self-efficacy and verbal persuasion, and (3) purpose of the present study.

Mode of Presentation of Instructional Material

Pictorial versus print modes.

In a research study conducted by Goldberg (1974), 216 fifth-grade children (113 boys, 103 girls) were presented with illustrated or nonillustrated incidental information (i.e., information which subjects were not aware they needed to remember). The primary purpose of the study was to determine whether illustrations facilitate incidental learning. The subjects within each class were paired according to

reading scores obtained on the Metropolitan Achievement Test. Each member of the matched pair was then randomly assigned to the imagery or nonimagery group. The imagery and nonimagery groups differed by the presence or absence of illustrations for their incidental-learning materials. The incidental learning materials consisted of prose material relating to social studies or science facts. A fixed amount of time was alloted for text comprehension and the tests. One recall (fill-in) and one recognition (multiple choice) test were administered to all children. The main effect of imagery was significant; the higher scores obtained by the imagery group in both curricular areas clearly demonstrate that illustrated incidental material was better retained than nonillustrated incidental material. Most children also scored higher on incidental-learning recognition questions than on recall questions.

In a study by Peeck (1974), 71 fourth graders read an adapted version of a "Rupert Bear" story. Subjects were given either an illustrated or a nonillustrated text while the retention test

contained questions on elements exclusively present either in the pictures, or in the text, or present in both pictures and text. In order to secure as natural a reading process as possible, the children were not given any learning instructions (i.e., the children were not instructed to remember the material) nor were they prepared for a retention test. Testing for retention took place (a) immediately after completion of the story, (b) after 1 day, and (c) after a week. The subjects were allowed to read the material at their own pace. Results showed that retention of the text contents was higher in the illustrated than in the nonillustrated condition. Participants in the illustrated condition retained significantly more picture-plus-text contents than children in the nonillustrated condition for the immediate and delayed measures.

In a study by Haring and Fry (1979), participants were 75 fourth graders and 75 sixth graders from a middle-class school. A 360-word version of "Mercury and the Woodcutter" from Aesop's Fables was adapted for this study. A

system of prose analysis was used to analyze the story into 350 idea units (i.e., words used in the passage, terms specifying the roles or relationships between those words, and terms specifying the relationships of ideas in the narrative). Two sets of pictures were drawn to be completely redundant with the text they illustrated. The children were assigned to one of three conditions. The first condition consisted of a text with a set of 10 pictures depicting only 179 idea units. The second condition consisted of a text with 13 pictures that were more detailed and depicted all 350 idea units. Children in the third condition received the text with no pictures. Thus, each student received a copy of the story in a booklet with one of the two sets of pictures interspersed or with no pictures. The students were instructed to read the story once at their own pace after which they were asked to write everything they remembered about the story. Unannounced, 5 days later, all participants were again asked by the experimenters to write all they could remember of the story. Results revealed that

children in the two picture conditions recalled significantly more idea units both immediately and 5 days later than did children in the no-pictures condition. The more detailed pictures did not facilitate significantly more recall. The interaction of grade and time of recall was not significant. However, main effects were found for grade and for time of recall.

In a study by Rusted and Coltheart (1979), 72 children (9-year-olds) were required to read descriptive passages presented with line drawings (pictorial) or without line drawings (nonpictorial) of the subjects of those passages. The 36 poor readers had a mean chronological age of 8.3 years. Six short factual passages were contructed, each having as its subject a highly unusual plant or creature. Each passage was constructed both with and without a black outline drawing of the subject. The six passages were randomly divided into two sets of three. Each student received both sets, one set with pictures and the other set without. Each passage was read twice to familiarize the children with the words in the passages. About 5

to 7 min following the second reading, participants were required to verbally recall (immediate recall) all they could of the passages. Students were then instructed to write down the list of names of the six creatures from the passages (delayed recall). Results show that in the immediate recall, the children recalled significantly more features from the passages presented with pictures than from those presented without. This pattern of results was repeated in delayed recall where children still recalled more from passages presented with pictures. Further analyses also showed that in immediate recall, a significantly greater proportion of nonpictorial features were remembered compared to delayed recall. There was no significant overall conditions difference in the proportion of pictorial and nonpictorial features recalled in delayed recall. However, in the picture condition, a higher proportion of pictorial features was recalled, while the reverse was true in the no-picture condition. The effect of presentation condition was significant with more of both pictorial and nonpictorial features recalled

in the picture condition than in the nonpictorial condition.

In a study by Rusted and Hodgson (1985), 9-year-old children (40) were required to read either factual or fictitious passages, presented with or without a relevant picture. Two passages, one factual and one fictitious, were written about each of six unusual creatures. For each creature, the factual passage presented a short description, while the fictitious text provided a short story, relating an incident involving that creature. The two texts contained the same eight critical facts about the creatures, four physical features which could be portrayed pictorially and four nonpictorial features concerning living/eating habits. Type of passage (factual/fictitious) was a between subjects variable, with 20 children randomly assigned to each condition. Students were told that the study was about remembering and that they would be asked to read some short passages and afterwards to recall all they could about each. Results revealed no significant difference in critical feature recall between the factual and the

fictitious passages. The presence of a relevant picture significantly improved recall. There was also a main effect for type of features recalled, with more nonpictorial features being recalled than pictorial ones. There were two significant interactions in the analysis. In the interaction of type of passage and presence/absence of illustrations, the illustrations had a greater effect on recall when presented with the factual texts. Test of simple main effects indicated that the advantage of illustrated over unillustrated texts was significant for factual passages only. The other significant interaction occurred between presence/absence of illustrations and pictorial/nonpictorial feature recall. Tests of simple main effects indicated that the presence of illustrations significantly improved recall of pictorial facts but not of nonpictorial facts (i.e., descriptions that were not shown in an illustration). Although the three-way interaction between passage type, illustrations, and feature type was not significant, planned comparisons indicated that, for factual passages, illustrations

significantly improved recall of both pictorial and nonpictorial facts. For fictitious passages, illustrations significantly improved recall for pictorial facts but not for nonpictorial facts which tended to be recalled better in the absence of illustrations.

Dwyer and De Melo (1984) conducted an experiment with 151 undergraduate students which was designed to investigate the effect of several different variables on information acquisition: (a) mode of instruction [verbal (printed) instruction alone versus verbal instruction complemented by simple line drawings], (b) mode of achievement test [visual testing (presence of pictorial cues to supplement test material) versus nonvisual testing (absence of pictorial cues to supplement test material)], (c) mode of drawing test [verbally cued (i.e., names of parts of the heart were given) versus free recall (i.e., names of parts of the heart were not given)], and (d) order of drawing test (before or after taking the identity, terminology, and comprehension tests). The material used in this

study was a 2,000-word instructional booklet describing the human heart, its parts, and the internal processes that occur during the systolic and diastolic phases. Results showed that the visual version (printed prose complemented by simple line drawings) of the instructional unit significantly improved students' information acquisition on both the immediate and delayed retention tests as compared to printed prose alone. Students who received the nonvisual test format (printed prose only) achieved higher mean test scores than those who received the visual version of the same tests. However, these differences disappeared on the 2-week delayed retention tests. The criterion tests were constructed to measure recall and recognition of the instructional material. The nonvisual testing mode was found to be more effective for the comprehension scores and total scores on tests of immediate and delayed retention. The order of drawing test and mode of drawing test had no significant main effects on the students' performance on the tests.

Summary: Pictorial versus print. Researchers have generally found that pictures are effective supplements to the retention of prose material when such pictures are well-designed and congruent with prose content and sequence. Nevertheless, the relative information carrying value of verbal and visual presentations is not clear. Some researchers who have compared the effectiveness of verbal and pictorial presentations of the same information have concluded that verbal presentations are equally effective as pictorial presentations, noting that during delayed recall, there was no significant difference between pictorial and nonpictorial features. However, conflicting results have been reported. Consequently, definitive findings about the effectiveness of different presentation modes for transmitting information are not readily derived from existing research. Combined pictorial-print modes, on the other hand seem to be more effective than single mode presentations in the retention of content material.

Pictorial versus audio. A study done by Friedlander, Wetstone, & Scott (1974), measured preschool children's comprehension of visual and verbal elements in a 3 min age-appropriate informational television program. Thirty-one children with ages ranging from 4- to 6-years-old participated. Recall performance was measured through questions for which the information available was presented both visually and auditorily, visually only, or auditorily only. More than half of the children demonstrated comprehension of less than half of the tested information. Analysis of the data indicated that the children did comprehend the general flow of ongoing activity but demonstrated poor comprehension of statements of fact related to the central theme, and of elements presented either in visual or auditory modality alone. Recall performance was significantly higher on the audio-plus-visual questions. In general, the study found that the verbal-visual form of presentation was better recalled than single-mode presentations.

In an experiment (Experiment 1) conducted by

Levin and Berry (1980), 50 fourth-grade children were randomly assigned in equal numbers to picture and control conditions. In the picture condition, the children were shown text material with accompanying illustrations while they listened to a series of newspaper stories. In the control condition, the children simply listened to the stories and saw no pictures. Five human interest and novelty stories were gleaned from local newspapers and each article was condensed to approximately 100 words. All resulting stories were ascertained to be at a fourth-grade reading level. For each passage, a single 8 1/2 x 11 in. (21.59 x 28.49 cm) colored line drawing was constructed to illustrate the main idea of the passage. Six short-answer paraphrase questions were composed for each passage. The child's task was to remember the content of the newspaper articles. Results indicate that for pictured information, the average recall of picture subjects surpassed that of the controls. Moreover, for nonpictured information, the recall means were quite similar. Thus, it was concluded that text-

relevant pictures facilitated recall of information.

The second experiment by Levin and Berry (1980) was conducted to determine whether the effects observed in Experiment 1 would be the same when the interval between presentation and testing was longer. The subjects in this second experiment were 37 fourth-graders. Nineteen children were randomly assigned to the picture condition, and 18 to the control condition. A sixth newspaper passage was developed and added to the previous five. The number of questions per passage was reduced from six to four, with two relating to pictured and two to nonpictured information. After presenting the material to the children, recall of the passage's content was assessed 3 days later in the same manner as in Experiment 1. Even though the overall level of recall was lower than that of Experiment 1, the pattern of recall differences between the experimental and control groups in the two experiments was similar. The average recall of pictured information by picture subjects was significantly higher than that of control subjects.

Picture and control students also did not differ significantly with regard to recall of nonpictured information. Thus, the picture effect was replicated using the present newspaper passages, even with a 3-day interval between the initial presentation and subsequent test.

A study by Carey and Hannafin (1981) examined the relationships among presentational stimuli (oral, visual, oral-plus-visual), types of content (concrete, abstract), and learner ability (high verbal, low verbal). A total of 248 third grade students either heard a short story, watched pictures showing the same short story, or heard and watched a combination of the oral and picture presentations. All presentations lasted 15 min to control time on task. Student recall of concrete and abstract information was measured by a recall test immediately after and 2 weeks after the presentations. A second dependent variable was a measure of mislearning (i.e., information that was not "correct," but was learned and remembered). This score was derived by counting the number of items for which a subject had made the same

incorrect response on both the immediate and delayed tests. Students learned as much or more concrete and abstract information from pictures as from oral prose, and learned the most information from the combination of oral prose with pictures. Mislearning of concrete and abstract information, such as repeating the same incorrect response on both immediate and delayed tests, was higher from the picture presentation than from the oral presentation, and lowest from the combination of oral prose with pictures. Significant interactions were not found among types of presentational stimuli, types of content, and levels of learner ability.

In a similar study by Hannafin and Carey (1981), a total of 152 fourth grade students participated in a study examining the effects of visual-only, verbal-only, and combined audiovisual (or visual-verbal) prose presentations and different elaboration strategy conditions on learning of abstract and concrete prose. The students saw and/or heard a short animated story, during which they were instructed to think of

pictures, think of words, draw pictures, write sentences, or use their own personal strategy to help them remember the material. A test measured recall of concrete and abstract prose immediately after and 1 week after the presentations. The audiovisual group recalled significantly more concrete and abstract information than students in the other groups, while the visual-only group had higher recall of concrete prose than did the verbal only group. Repeated errors (making the same incorrect response in both the immediate and the delayed tests) were lowest in the combined audiovisual group. The visual-only group made more repeated errors for abstract prose than did the verbal-only group, but this pattern was reversed for repeated errors in concrete prose recall. Students using pictorial elaboration strategies made fewer repeated errors than did students using other elaboration strategies.

A study by Welch (1982) investigated the learning impact of audio, visual, and audiovisual information channels in televised messages among 50 4- to 6-year old preschool children. The messages

were contained in a videotape which consisted of a half-hour "Mister Roger's Neighborhood" program and a program of 12 selected segments of "Sesame Street." A second videotape was prepared containing the same programs but the position of segments of the programs was reversed to control for the order effects on learning. Each child viewed one of the videotapes once. Immediately after the tape ended, the experimenter administered a recall test which was broken down in terms of the mode by which the information necessary to answer the question was presented (audio track, the visual track, and both tracks congruently). Results of the study indicated that audiovisual messages and visual messages were recollected significantly better than audio ones. There was no significant difference between audiovisual and visual messages.

Hannafin (1983) examined the effects of different presentation modes and verbal ability on the recall of abstract and concrete prose. The subjects were 180 third graders. Five different versions of a children's short story were developed. All were adapted from "Wump World"

which dealt with fictitious invaders of a fictitious world. The five presentation conditions were: ORAL, an audiotape presentation of the story; SIMPLE, a slide presentation of the illustrations used in the text of the short story; CLOSE-UP, the same sequence of slides used in the SIMPLE condition, with additional close-up pictures of criterion information distributed throughout the story; ORAL + SIMPLE, a combination of the audiotape and the SIMPLE slides; and ORAL + CLOSE-UP, a combination of the audiotape and CLOSE-UP slides. Time on task was controlled within the rates and segments of the story (i.e., the pace of the presentation for the ORAL and SIMPLE conditions was congruent with the pace of the ORAL presentation), permitting an exact equalization of the pacing of the presented information. The two dependent variables were abstract recall and concrete recall which were measured through a short answer essay test. The test was administered orally by audiotape. The subjects saw and/or heard the presentation in accordance with treatment and group assignment. The test was given immediately

after presentation and repeated 2 weeks later for a measure of delayed recall. The group receiving the ORAL + CLOSE-UP picture presentation obtained the highest mean performance on both immediate and delayed tests, followed by the groups presented ORAL + SIMPLE picture, CLOSE-UP picture, SIMPLE picture, and finally ORAL only prose presentation. The performance yielded by bimodal presentations not only resulted in a predictable improvement overall, but also in a predictable improvement of each progressively loaded level of presentation. A significant main effect was found for test scale with students recalling more concrete than abstract information. The findings in this study supported the hypothesis that combined oral-picture presentations resulted in superior learning of both concrete and abstract content.

In a follow-up study by Hannafin (1984), a total of 121 third and fourth graders were randomly assigned to instructional treatment groups, each of which featured a short children's story. The purpose of this study was to investigate the relative effectiveness of different verbal versus

pictorial versus verbal-pictorial presentations on student recall of concrete and abstract prose. Three treatment presentations, each depicting an adapted children's text, "The Wump World," were used. The three presentations included: ORAL, an audiotape verbal presentation of the story; PICS, a slide presentation of the text pictures used to depict the story; and ORAL + PICS, a combination of the audiotape and slides. Each version was 18 min in duration and paced identically to control student time on task. The criterion measure was a short-answer test, measuring recall of abstract and concrete information. All test directions and questions were presented once and paced through audiotape. The criterion test was administered immediately after the presentation and 1 week later as a measure of delayed recall and retention. Recall of concrete information was significantly greater than abstract recall. The ORAL + PICS presentation was consistently the most effective for both abstract and concrete recall. The mean scores obtained by the ORAL and PICS presentation groups for abstract recall were comparable but the

PICS presentation was significantly more effective than the ORAL presentation for recall of concrete content. In effect, picture presentations were relatively more effective overall than oral-only.

A study by Pezdek and Stevens (1984) examined the relationship between children's cognitive processing of video (visual) and audio information on television. Ninety-six 5-year-old children viewed a videotape segment of "Sesame Street" followed by a comprehension test and a recognition test. Equal numbers of subjects viewed an experimental segment in which (a) the audio and video tracks were from the same segment (audiovisual match), (b) the audio and video tracks were not from the same segment (audiovisual mismatch), (c) the video track was presented alone, or (d) the audio track was presented alone. The design allowed unconfounded comparisons of modality-specific processing. In the audiovisual mismatch condition, memory for audio information was reduced more than memory for video information. However, comprehension and recognition of audio information was similar in the audio-only and

audiovisual match conditions. These results suggest that in regular television programs, the video information does not interfere with processing the audio information, rather, the video material simply appears to be more salient and more memorable than the audio material.

Field and Anderson (1985) examined 5- and 9-year-old's television viewing and program recall in response to learning instructions. The television program consisted of segments that emphasized visual information, auditory information, or information presented redundantly in both auditory and visual modalities. The 80 children were shown a 35 min color videotape containing six short segments. The program included the three types of modality emphasis. Two of the segments were primarily visual, most of the informative content was communicated visually, with very little information provided by the auditory modality. These segments were animated stories with musical accompaniment. Two other segments contained mainly auditory content, with little or no informative support from the visual modality. Puppet skits

composed of dialogue among characters who moved very little around a fixed background were used. The third type of story emphasized audiovisual content, in which the central material was presented on both the auditory and the visual channel. The same information could be learned by either listening or viewing. Recall questions were designed to examine learning of auditory, visual, and audiovisual content. Recall of information was significantly better for audiovisual emphasis than for visual or auditory among the younger children. Among the older children, auditory and audiovisual material were recalled much better than among younger children. The general finding, however, was that audiovisual information increased attention as well as recall.

Summary: Pictorial versus audio. Again, the bimodal mode (pictorial-plus-audio) was generally found to be more effective than single mode presentations. Support for the effectiveness of the visual mode is evident in some studies. In other studies, however, comparison of recall between pictorial versus audio features of an

instructional material showed varying results. Some studies pointed to the superiority of the visual mode while others did not find any significant difference between the pictorial and audio modes of presentation whether the information was concrete or abstract.

Print versus audio. In a study by Van Mondfrans and Travers (1964), students were given a series of learning trials with stimulus materials of differing degrees of meaningfulness and redundancy using three modes of presentation. The first experiment tested the hypothesis that when redundant information is transmitted simultaneously through two sense modalities, more information is retained than when only one modality is involved. The modalities used were those of vision and hearing. Participants were 72 undergraduate students randomly assigned to the experimental conditions. The stimulus materials were nonsense syllables in one learning condition, words in a second learning condition, and words with constraint (i.e., words arranged to form a sentence) in the third learning condition. Each

list of nonsense syllables was presented with each mode of presentation so that the effects of inter- and intralist similarity were counterbalanced. Half of the students participated under a 4 s stimulus presentation and for the rest of the subjects stimuli were exposed at a 2 s rate. Each student was assigned to a learning condition (nonsense syllables, words, or words with constraint), to an order of lists (there were three different lists in each learning condition), and to a sequence of treatments (auditory, visual in the form of printed material on film, and both). The auditory presentation was tape recorded. The visual presentation was presented using a film strip, and the combined audio-visual presentation was presented using a synchronized combination of the tape recording and the film strip. In the auditory presentation, each nonsense syllable or word was pronounced only once, otherwise frequency of information presentation was not controlled. After each complete presentation of a list, using one of the three different presentation modes, subjects were allowed 1 1/2 min in which to write

down as many of the nonsense syllables or words remembered. Student's scores were the number of errors made in learning the lists. The effects of time, material meaningfulness, modality, order, and the interaction between modality and the stimulus material were all significant. More was learned at the 4 s exposure rate than the 2 s rate, but there was no interaction between exposure time and the mode of presentation. The nonsense syllables tended to be more difficult to learn than the words. Words were not significantly more difficult to learn than the words with constraint. The first list presented was more difficult to learn than the second, and the second was more difficult to learn than the third. The auditory presentation was significantly less efficient than the other two, and there was no significant difference between the visual presentation and the audio-visual presentation. The only significant interaction was meaningfulness of material and mode of presentation. When the stimulus material was nonsense syllables, the auditory mode of presentation produced learning inferior to the

other two, which were similar.

Young (1973) compared reading and listening comprehension and retention. Ninety undergraduates were randomly assigned to each of the two experimental groups, and 31 students participated in a control group. The stimulus material consisted of 14 informative messages; each message was about 1 1/2 min in length and covered a variety of topics. The test consisted of six multiple-choice items for each of the messages. For the listening group, an audiotape of the 14 messages was prepared. For the reading group, the messages were prepared on 16 mm silent motion picture film in a manner that presented each message one line at a time. Each line was shown for a length of time which would give an overall time for each message corresponding to the time taken to record the message on the audiotape. This was done to control for the rate of presentation. The tests were administered immediately after the presentation of each of the messages. One week later, as a measure of retention, students took the test again without hearing or reading the messages. Control subjects

were permitted to read at their own speed and to respond to the test items (immediate test). No retention measure (delayed test) was obtained for their group. The analysis revealed a significant main effect for time of testing, the scores on the delayed test were significantly lower than the scores on the immediate test. No other comparisons were significant.

Summary: Print versus audio. Van Mondfrans and Travers (1964) indicated that the auditory presentation was significantly less efficient than print-only and auditory-plus-print modes and that there was no significant difference between print-only and auditory-plus-print modes. In contrast, Young (1973) found no significant difference between readers and listeners of the same content material on either the immediate or delayed tests. Certain factors may have accounted for the difference in findings of these two studies. In the study by Van Mondfrans and Travers (1964), the frequency of presentation of the visual and audiovisual material was not controlled, although the audio material was only presented once. The

content to be learned was relatively simple material. Young's (1973) study, on the other hand, focused on the retention of content material in which frequency of presentation was controlled for and the material was comparatively complex.

Pictorial versus print versus audio. In a study by Rohwer and Harris (1975), prose learning in high socioeconomic status (SES) white and low SES black fourth-grade children was assessed as a function of presentation media, test-item structure, and response methods. The seven presentation conditions included both single media (oral, print, and pictures) and combined media. The study materials were prose passages in which two related concepts (two types of monkeys, two tribes of people, two cars) were contrasted. A passage consisted of two paragraphs, each devoted to a description of one of the concepts. Three single-medium versions of the passages were constructed: oral, print, and pictorial. Oral presentation was accomplished by the playback of audiotape recordings of each passage. Printed versions of the passages were presented in slides.

All three of the passages were presented successively to each of the 168 children by means of one of the seven combinations of media. The presentation rate was constant across media conditions, that is, for the visual media, slides appeared at the rate of one every 20 s and for the oral materials, 20 s elapsed between the onset of one group of two sentences and the onset of the subsequent group. This rate was selected as the time required to register all of the material offered in the oral-plus-print-plus-pictures condition. The learning of the material was tested by means of short answer and free recall methods. The free recall method disclosed a significant advantage for print over oral presentation mode. There was also a significant advantage of oral over picture presentation, however, the beneficial effect of oral presentation was apparent in the high SES white children but not among the low SES black children. There was a significant main effect favoring print over pictures; the interaction with SES was not significant. Thus, when considered by itself, the pictorial medium

appears inferior to each of the verbal media, oral and print. Regarding combined-media comparisons for high SES white childen, the oral-plus-print condition was, for the most part, inferior to the other two conditions which did not differ significantly, while for low SES black children, the oral-plus-pictures condition was regularly superior to the remaining conditions which were largely equivalent in their effects. Finally, performance in the three-media condition (oral-plus-pictures-plus-print) did not differ significantly, in either SES group, from performance in the dual media conditions. For the low SES black children, performance in the combined media conditions, especially in oral-plus-pictures, was superior to that in single-media conditions, whereas among high SES white subjects combinations of media were of little benefit.

Nasser and McEwen (1976) hypothesized that when the same verbal content is delivered across media (television, audio, print, print-plus-audio), bimodal media will elicit higher recall. The 100 college students, in this study were randomly

assigned to one of four treatment conditions: audio alone, print alone, print-plus-audio, and videotape. After exposure to the experimental broadcast message through the assigned media channel condition, subjects were given a recall test. The message used was a broadcast on trade possibilities with China; all four versions of this broadcast were taken from the same manuscript. The audio version was taped directly from the videotape version. The print-plus-audio version was a combination of the audiotape recording and a slide presentation of the written transcript. Slides were arranged so that they would correspond to natural pauses in the audio version to aid in sychronization of tape and slides. The print version was the same slide projection employed in the print-plus-audio condition, with the exception that each student, through a hand control, could operate the speed of the projector. Recall was measured by a multiple-choice exam. Results indicated that print-plus-audio elicited higher recall than audio alone. The other comparisons were not significant, that is, there were no

significant differences between videotape and print-only, videotape and audio-only, and print-plus-audio and print-only.

Browne (1978) compared factual recall from film and print stimuli. The primary hypothesis in this study was that reading the written version would lead to better recall than watching the film documentary. The documentary that was selected described the legislative process in Oklahoma. To measure recall, true or false and multiple-choice questions were used. Participants were volunteers from two jury pools at the Oklahoma County Courthouse. A total of 31 participants read the written feature and 32 watched the film. There was no significant difference between the reading and film groups on the pretest. The comparison between the reading and the film group after the media presentation indicated the reading group did better than the film group.

Peng and Levin (1979) found that story-relevant pictures significantly improved 64 second graders' recall of stories, both immediately after hearing the stories, as well as 3 days later. The

learning materials were two 10-sentence narrative stories recorded on tape. Children in the control conditions listened to the stories while viewing a typewritten version presented sentence by sentence on index cards. Children in the picture conditions heard the stories while viewing a series of colored line drawings, each picture capturing the content of each sentence. The recall questions were recorded on tape, and the subjects were allowed as much time as necessary to respond to each question. It was found that over a 3-day period, story-relevant pictures helped children recall stories. Although they had more to forget, children aided by pictures did not forget more than those in the control groups.

Fleet (1980) studied the effectiveness of four types of presentation modalities for facilitating retention. Subjects consisted of 100 black undergraduate students. There were four experimental treatment groups of 25. These groups varied in terms of mode of presentation (live, video-audio, audio, and manuscript). The retention measure was a multiple-choice test. The

presentation involved a speech delivered by a person who was not known to any of the subjects. For the live presentation, students reported to a studio where the speech was delivered. For the video-audio presentation, a video-audio tape of the live presentation was used. For the audio presentation, the audio portion of the video-audio tape was presented. For the manuscript presentation, each subject silently read a printed copy of the presentation. The audio-video and the audio presentations were presented only once, while the reading of the manuscript was self-paced. There were no significant differences between the groups in the amount of content retained.

Nugent's (1982) research studied whether presentations by an iconic system (pictures) or a linguistic system (print or audio) aided the learning of 201 fourth-to-sixth graders. The instructional materials were prepared from a nonverbal film that presented factual information about the life of a cheetah. The seven instructional treatments to which each student was randomly assigned were: visuals-plus-print

(videotape of film with subtitles), visuals-plus-print-plus-audio (videotape of film which contained the audiotrack and subtitles), visuals-plus-audio (videotape of film with audiotrack), print-plus-audio (videotape of subtitles only with audiotrack), visuals alone (videotape of film alone), print alone (videotape of subtitles alone), and audio only (audiotrack alone). A multiple choice comprehension test was given after the presentation of the material. The students learned equally well from print, visuals, and auditory presentations. The audio-plus-print presentation, in which information was presented through a linguistic or verbal symbol system, did not have an advantage over single presentations in either mode. On the other hand, presentation of information by both pictorial and linguistic modes was generally more powerful than single presentations. It was pointed out that the iconic system is presumably more specialized in processing concrete objects and events, and the linguistic system provides semantic orientation, and the two can interact and work jointly in facilitating

learning.

In a study done by Joseph and Dwyer (1984) the same prose material from Dwyer and De Melo (1984) was used as the instructional unit. The sample consisted of 414 tenth grade public school students enrolled in mandatory health classes. Three factors were examined. First, the question of whether all types of visuals [i.e., line drawings, realistic photographs, hybrid (a picture of the heart, half of which was in the form of a line drawing and half in the form of a realistic photograph), and a combination of line drawings and realistic photographs] are equally effective in facilitating student achievement was examined. Second, they tested whether students' prior knowledge of the content affects their ability to profit from visualization as reflected in performance on criterion tests. Third, the effectiveness of externally-paced method (i.e., audio version of content material presented by means of a tape recording) and self-paced method (i.e., print version of content material) of presenting visualized instruction on immediate and

delayed retention of the content was assessed. The modes of presentation were print-only (self-paced), pictorial-plus-print (self-paced), audio-only (externally-paced), and pictorial-plus-audio (externally-paced). The dependent measures were a drawing test, an identification test, a terminology test, and a comprehension test. Each test was administered twice--immediate testing and 2 weeks later for delayed testing. Findings indicated that for the drawing test, the students receiving the externally-paced instruction (print-plus-audio) scored significantly higher than students receiving the self-paced instruction (print-only). There were no significant differences among means of the types of visuals for those with low prior knowledge. For those with medium prior knowledge, receiving the combination of line drawing and realistic photograph was significantly more effective than the nonpictorial condition (i.e., print-only or print-plus-audio) in facilitating student achievement. For students with high prior knowledge, the realistic photograph and hybrid picture conditions were significantly more

effective than the nonpictorial condition. For the identification test, there were no significant differences among the types of visuals means for the low prior knowledge group. However, for the medium prior knowledge group, the externally-paced combination of line drawing and realistic photograph condition (pictorial-plus-print-plus-audio) and self-paced combination (pictorial-plus-print) condition were significantly more effective than the nonpictorial condition. For the high prior knowledge group, the externally-paced combination picture condition (print-plus-audio-plus-combination pictorial) was significantly less effective than all the other types of visuals including the no visual condition. For the high prior knowledge groups that were self-paced (i.e., print-only, pictorial-plus-print), the realistic photograph condition was significantly more effective than the nonpictorial condition. The results on the total score (i.e., sum total of scores for all four tests) analysis were similar to the results on the identification test except that for the self-paced, medium prior knowledge

subgroup, there were no significant differences. No significant findings for mode and pacing method were found for the terminology and comprehension tests. It was also found out that students with high levels of prior knowledge achieved equivalent or significantly higher scores on the criterion measures than students with low and medium prior knowledge regardless of the type of visual or mode of instruction received. The main effect for the type of visual did not yield any significant results. No relevant findings were found in the delayed testing data.

Pezdek, Lehrer, and Simon (1984) compared the relationship between comprehension and memory for text and television, and comprehension and memory for text and radio. The subjects were 48 third graders and 48 sixth graders. The primary independent variables in the experiment were age and media condition. Half of the subjects participated in a reading and television condition, and half participated in a reading and radio condition. Two folk tales were edited such that there were three matched versions for each story:

(1) a storybook with colored pictures, (2) a radio version, and (3) a color television version. The audio tracks in the television and radio conditions were identical, and these were the same as the transcript of the book. The same material was thus included in each condition, with the addition of still pictures in the storybook version and animation in the television version. Each child read one story and was presented either the radio or television version of the other story, with the assignment of story to media condition counterbalanced across participants. Children read the stories aloud to ensure that they read the complete story and decoded words correctly. Immediately following each task, participants were presented the appropriate memory and comprehension tests. Television was superior to radio on the comprehension and sentence recognition tests. Within subjects comparisons of performance in the television and reading conditions revealed similar levels of performance on most measures. Within subjects comparisons of performance in the radio and reading conditions revealed a superiority of

the reading condition over the radio condition on the comprehension and sentence recognition measures. Thus, children generally performed at similar levels in the television and reading conditions, and better in both of these conditions than in the radio conditions.

Summary: Pictorial versus print versus audio. In comparing combined modes of presentation, studies have generally shown that materials using pictures and audio produce learning superior to that involving audio and print, pointing out the advantage of pictorial versus printed modes or orally presented information. Pictorial-plus-print was also found to be more effective than print alone. Moreover, these studies have indicated that recall performance in three-media conditions does not differ significantly from performance in dual-media conditions. The presence of illustrations to supplement print or audio seems generally sufficient to elicit the best recall. Transmission of redundant information (i.e., information presented more than once) through more than one channel generally improved retention superior to

that of a single channel. This is the case for pictorial-plus-print, pictorial-plus-audio, and pictorial-plus-print-plus-audio, but not print-plus-audio. In comparing narratives presented in print versus audio form, no differences were found in the learning of younger children and college students. With college-level prose material, print-plus-audio was superior to audio alone, but print-plus-audio presentation had no advantage over print-only materials.

Summary

The available research evidence leads to the conclusion that pictorial-plus-audio and pictorial-plus-print presentations, ones in which there are visual supplements for the verbal information, will be learned and remembered significantly better than presentations without such visual tags. In other words, there is improved recall and recognition of information if the mode of instructional presentation is pictorial-plus-audio or pictorial-plus-print. Most of the research points to the superiority of joint or combined modes of presentation, however, the combination of two

verbal sources does not follow this pattern. The pictorial-plus-print-plus-audio mode do not seem to differ significantly from the dual-mode presentations. In examining single comparisons, or learning from either print, audio, or visuals (e.g., drawings, pictures), the research presents conflicting results. Most of the literature reviewed focused on the verbal (print or audio) as the primary source of information using visuals as supplementary device to possibly improve retention of content material. This is probably so because, generally, communication among humans is verbally transmitted through language. With regard to the relative merits of visual-only versus audio-only presentations, the evidence is conflicting. Those studies supporting the superiority of visual information tend to rely on the literature regarding the iconic quality of children's cognitions. On the other hand, those supporting the superiority of the verbal (print or audio) mode of presentation tend to refer to the same literature but from the perspective that young children do not remember things verbally, and do

not spontaneously associate remembered images with their verbal labels and therefore, when the learning measures involve verbal recall, are most helped when the verbal labels are provided for them (Welch, 1982). In sum, the review of the literature on mode of presentation generally points to the superiority of bimodal modes, which do not significantly differ from the trimodal presentation (pictorial-plus-print-plus-audio), over single-mode presentations. Moreover, studies have shown that materials using pictures-plus-audio and/or pictures-plus-print are superior to that involving print-plus-audio.

Self-Efficacy and Verbal Persuasion

Since no study from the literature gathered has specifically addressed the variable of preconceived degree of difficulty in relation to memory, the closely related concept of self-efficacy was reviewed. I have defined preconceived degree of difficulty as a person's belief in the level of difficulty of a specified task prior to the actual undertaking of such task. Based on this definition, the concept of self-efficacy, in my

opinion, is closest in meaning to preconceived degree of difficulty and will thus be discussed in this section.

According to Bandura (1982a, 1982b), self-efficacy is a major factor which influences one's choice of activities, effort expended, persistence, and task accomplishments. Although self-efficacy was originally used to help explain coping behaviors in fearful situations, its use has been extended to other situations, including cognitive-skill learning (Schunk, 1985).

Bandura (1982b) pointed out that "self-percepts of efficacy influence thought patterns, actions, and emotional arousal. The higher the level of induced self-efficacy, the higher the performance accomplishments. Perceived self-efficacy helps to account for such diverse phenomena as changes in coping behavior produced by varied conditions, resignation and despondency to failure experiences, and achievement strivings." (Bandura, 1982a, p. 122). People often do not perform optimally, even though they know fully well what to do. This is because self-referent thought

also mediates the relationship between knowledge and performance. Acting on misjudgments of personal efficacy or the belief that a task is too difficult for one's capabilities can produce adverse consequences. People tend to avoid activities that they believe exceed their coping capabilities, but they undertake and perform assuredly those that they judge themselves capable of managing (Bandura, 1977). Judgments of self-efficacy also determine how much effort people will expend and how long they will persist in the face of obstacles or aversive experiences. From the social-learning viewpoint, judgments of self-efficacy, whether accurate or faulty, are based on information we receive about ourselves and the tasks we undertake. Verbal persuasion is one of the widely used methods to get people to believe they possess capabilities that will enable them to achieve what they seek (Bandura, 1982b). Although social persuasion alone may be limited in its power to create enduring increases in self-efficacy, it can contribute to successful performance if the self-appraisal is within realistic bounds.

Persuasive efficacy influences, therefore, have their greatest impact on people who have some reason to believe that they can do a task (Chambliss & Murray, 1979a, 1979b). Perceptions of self-efficacy affect emotional reactions as well as behavior. This is especially true of anxiety and stress reactions to unfamiliar or potentially aversive events. Self-efficacy theory suggests an alternative way of looking at human anxiety (e.g., test-taking conditions).

In attempts to influence human behavior, verbal persuasion is widely used because of its ease and ready availability. People are led, through suggestion or instruction, into believing they can cope successfully with what may have overwhelmed them in the past. As Bandura stated, "efficacy expectations included in this manner are also likely to be weaker than those arising from one's own accomplishments because they do not provide an authentic experiential base for them" (Bandura, 1977, p. 198). Since these studies do not deal with the issue of memory and learning, the results will not be discussed.

In the study by Schunk and Cox (1986), the self-efficacy model was tested with 90 learning disabled students who performed below their measured abilities but did not possess intellectual deficits. This experiment investigated how verbalization in solving math problems (as a method to increase feelings of self-efficacy) influences performance and also explored how effort-attributional feedback affected such performance. The students (Grades 6 through 8) received training and solved problems over sessions. Students in the first condition verbalized aloud while solving problems (continuous verbalization), those in the second condition verbalized only during the first half of training (discontinued verbalization), and those in the third condition did not verbalize (no verbalization). All the students were periodically monitored and received effort feedback during the first half of training, effort feedback during the second half of training, or no effort feedback. Continuous verbalization led to better performance than did discontinued and no verbalization. Providing effort feedback promoted these

achievement behaviors more than not providing feedback.

The present study investigated the effects of preconceived degree of difficulty through the use of verbal persuasion on the student's ability to remember prose material. Another aspect of the study was to determine how preconceived degree of difficulty interacts with various modes of presentation on the retention of content material.

Purpose of the Present Study

In the literature reviewed, the focus has either been on the effects of mode of presentation on learning and memory, or the concept of self-efficacy induced through verbal persuasion. However, the effects of preconceived degree of difficulty, as I have defined it, on learning and memory and its interaction with mode of presentation have not been researched based on my review of the literature from 1964 to 1986. My study focused on the interaction between these two variables which may reveal ways by which learning and teaching strategies may be improved. In the world of formal education, teaching should not only

focus on "external" teaching devices (e.g., visual aids) to help students but also on the "internal" cognitive factors affecting the learner during the learning process itself. The primary target of my study, thus, was to help find ways to improve formal education particularly at the secondary and collegiate levels since the material used to measure retention in this study has been used primarily with these populations.

This study analyzed the effects of the mode of presentation and the student's preconceived degree of difficulty of a memory task on the immediate and delayed retention of information. The modes of presentation that were studied were print-only, pictorial-plus-print, audio-only, pictorial-plus-audio, print-plus-audio, and pictorial-plus-print-plus-audio. The categories for the preconceived degree of difficulty were easy, neutral, and difficult. The purpose of the study was to empirically answer the following:

(1) Do the mode of presentation and preconceived degree of difficulty, each taken independently of each other, significantly affect

retention of information as measured by recall and recognition? Based on the literature reviewed on mode of presentation, I predicted that bimodal presentations involving pictures (i.e., pictorial-plus-print and pictorial-plus-audio) would yield higher scores than any of the single modes. Moreover, I expected the trimodal mode (i.e, pictorial-plus-print-plus-audio) would not yield significantly higher scores than the two bimodal modes I mentioned. These expectations yielded the following seven specific hypotheses for mode:

H1: Pictorial-plus-print mode condition would be significantly superior to print-only mode condition.

H2: Pictorial-plus-print mode condition would be significantly superior to audio-only mode condition.

H3: Pictorial-plus-audio mode condition would be significantly superior to print-only mode condition.

H4: Pictorial-plus-audio mode condition would be significantly superior to audio-only mode condition.

H5: There would be no significant difference between pictorial-plus-print-plus-audio mode condition and pictorial-plus-print mode condition.

H6: There would be no significant difference between pictorial-plus-print-plus-audio mode condition and pictorial-plus-audio mode condition.

H7: There would be no signficant difference between pictorial-plus-print-plus-audio mode condition and print-plus-audio mode condition.

(2) Is there an interaction between the mode of presentation and preconceived degree of difficulty in their effect on retention of information as measured by recall and recognition?

Method

Participants

The sample was composed of 112 undergraduate students (24 males, 88 females) from the University of the Pacific. They were chosen from selected psychology classes (Child Development, Behavior Change I, Abnormal Psychology, and Business, Engineering and Psychology) offered during the spring semester of 1987-1988. They were encouraged

to participate in the experiment by having their professor give them extra credit points for the class they were recruited from or by simply pointing out to them the benefits of participating in the research (e.g., contribution to psychological and educational research, personal enrichment). The total number of participants was composed of 93% students who received course credit and 7% undergraduate volunteers. Each participant was randomly assigned (with replacement) using the table of random numbers to the 18 different experimental conditions of the design. A limit of at least 5 participants for each experimental condition was imposed.

Experimental Design

The design was a 6 x 3 x 2 split-plot factorial design (SPF-63.2, Kirk, 1982) with two between-groups variables and one within-groups variable as follows: (a) mode of presentation (print-only, pictorial-plus-print, audio-only, pictorial-plus-audio, print-plus-audio, and pictorial-plus-print-plus-audio); (b) preconceived degree of difficulty (very easy, neutral, and very

difficult); and (c) the within variable of retention tests (immediate and delayed). The primary dependent variable was the student's total score on the four tests designed to measure retention of the information presented. The experimental design and the number of students in each condition is shown in Figure 1.

		Preconceived Degree of Difficulty		
		Easy	Neutral	Difficult
Mode of Presentation	print-only	6	5	6
	pictorial+print	8	5	6
	audio-only	7	5	7
	pictorial+audio	9	5	5
	print+audio	6	7	7
	pictorial+print +audio	7	5	6

Figure 1. Diagrammatic representation of the research design and distribution of the participants.

Content Material

Pictorial and print versions. The content material was a 2,000-word instructional booklet which described the human heart, its parts, and the

internal processes that occur during the systolic and diastolic phases (Dwyer, 1978) (see Appendix A). According to Dwyer (1978), the instructional content of this material was designed to reduce and control, as well as possible, deficiencies in past media research such as the incongruence between content material of different modes of presentation. He also cited some favorable characteristics of this material: specific types of educational objectives (e.g., terminology, comprehension) to be achieved were identified; a specific content area that permitted meaningful learning to occur was selected; four criterion tests measuring student achievement of the different types of educational objectives were constructed; and visualization was systematically integrated into the verbal content material (Dwyer, 1978).

The instructional material for the print-only and pictorial-plus-print groups was presented in the form of a booklet. Each booklet consisted of approximately 2,000 words of instruction that were arranged into 37 paragraph-type frames on 8 1/2 x

11 in. (21.59 x 28.49 cm) sheets. For students who participated in the pictorial-plus-print, pictorial-plus-audio, and pictorial-plus-print-plus-audio groups, each frame included a 3 x 5 in. (7.62 x 12.7 cm) illustration showing a black and white picture of the human heart specifically designed to visually depict the verbal information (see Appendix B). Thus, a total of 37 of these visual illustrations of the heart appeared in the instructional booklet. Words were printed in each illustration to facilitate the proper spelling of the term presented and to enable students to distinguish between those parts of the heart for which spelling and pronunciation are almost identical. These printed words were used in the instructional materials requiring a pictorial presentation mode and were located in about the same place on each page of an instructional booklet. Arrows were used in the illustrations to focus the students' attention on a specified part of the human heart being discussed. Figure 2a shows a sample page from the print-only instructional booklet, and Figure 2b shows a sample

page from the pictorial-plus-print version.

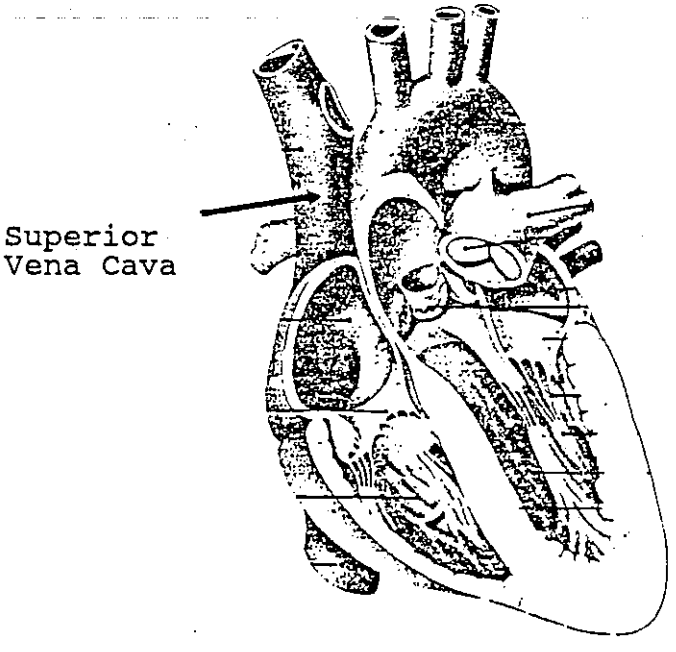
PRINT-ONLY INSTRUCTIONAL BOOKLET

Superior
Vena Cava

As you would view a cross-sectional diagram of the heart, blood enters the right auricle through veins. Only veins carry blood to the heart. The superior vena cava is one of the two veins which deposits blood in the right auricle. There are no valves at the openings of these veins into the right auricle. The superior vena cava drains blood into the right auricle from all body parts above heart level; i.e., head and arms.

Figure 2a. Sample frame from the print-only instructional booklet.

PICTORIAL-PLUS-PRINT INSTRUCTIONAL BOOKLET



As you would view a cross-sectional diagram of the heart, blood enters the right auricle through veins. Only veins carry blood to the heart. The superior vena cava is one of the two veins which deposits blood in the right auricle. There are no valves at the openings of these veins into the right auricle. The superior vena cava drains blood into the right auricle from all body parts above heart level; i.e., head and arms.

Figure 2b. Sample frame from the pictorial-plus-print instructional booklet.

To control for the frequency of presenting the instructional material, the students receiving the print-only mode were instructed to read the 2,000-word instructional booklet once and not to reread or go back to pages they had already read. This was monitored by at least two experimenters present during the experimental sessions. The purpose of controlling for frequency of presentation was to see which mode was more effective when frequency of presentation was constant across modes. The experimenters were an undergraduate psychology major, a psychology graduate student, and me. Students in the pictorial-plus-print group received the same verbal content as the students who received the print-only mode and were instructed to read the material the same way.

Audio version. The audio version of the content material, which was narrated by a female graduate student, contained the same information as the print-only version but in audio form. Thus, each participant was provided a headphone to hear a tape recording of the instructional material from a tape player instead of reading an instructional

booklet. The use of headphones minimized possible confounding effects of outside noises. Each student was also allowed to set the audio volume to the level they preferred. To control for the frequency of the presentation of the material, the audio tape was only played once and students were instructed not to play back the tape. The audio version was presented to the audio-only, print-plus-audio, pictorial-plus-audio, and pictorial-plus-print-plus-audio groups.

Preconceived Degree of Difficulty (PDD)

The instructional material for all presentation modes began with an introductory statement concerning the supposed degree of difficulty of the content material the student needs to study. Three different types of introductory statements on preconceived degree of difficulty were presented. These were as follows:

1. Very Easy: "The material you are about to read is classified as VERY EASY for COLLEGE FRESHMEN. This means that this material can easily be understood and remembered."

2. Neutral: "The material you are about to read is classified as AVERAGE in Difficulty for TYPICAL COLLEGE STUDENTS. This means that this material is neither too easy nor too difficult to be understood or remembered."

3. Very Difficult: "The material you are about to read is classified as VERY DIFFICULT for COLLEGE SENIORS. This means that this material cannot be easily understood or remembered. Careful attention, and concentration is extremely necessary."

To strengthen the impact of preconceived degree of difficulty, each category for this variable (e.g., very easy) was supplemented by verbal persuasion by having the experimenter read a script pertinent to the preconceived degree of difficulty level for that group (see Appendix C). The participants were also given a copy of the appropriate script and it was read to them prior to the presentation of the instructional material.

As a validity assessment, participants were asked their preconception of the difficulty level of the instructional material before and after the

immediate test by using a 5-point Likert scale item ranging from very easy to very difficult (see Appendix D). They were required to respond to the scale just prior to the reading or listening of the material and immediately after finishing all the immediate tests. From this validity assessment, it was found that the variable of preconceived degree of difficulty prior to the immediate testing was highly correlated with the students' ratings of their own preconception of the content material's difficulty level (r = .75).

Mode Conditions (Mode)

The different modes in which instruction was presented were as follows:

1. Print-only (PRI). The instruction booklet was presented without any audio or pictorial illustrations.

2. Pictorial-plus-print (PIC+PRI). The instruction booklet with pictorial illustrations was presented without any audio.

3. Audio-only (AUD). The audio version of the content material was presented without the instructional booklet which contains the verbal

content and pictorial illustrations. Each student was provided a headphone plugged to a cassette player to listen to the audio version of the content material.

4. Pictorial-plus-audio (PIC+AUD). The instructional booklet with pictorial illustrations but without the verbal content was presented together with the audio version of the content material.

5. Print-plus-audio (PRI+AUD). The instructional booklet without any pictorial illustrations and the audio version of the content material was presented.

6. Pictorial-plus-print-plus-audio (PIC+PRI+AUD). The instructional booklet which contained both verbal content and pictorial illustrations was presented together with the audio version.

Procedure

Each student in each experimental condition participated in one of the six modes of instructional presentations and one level of the preconceived degree of difficulty. Then, they each

took four separate tests. Answer sheets were provided to all participants (see Appendix E). The same tests were administered 1 week later, without presenting the instructional booklet again, as a measure of delayed retention of the content material.

The following is a description of each test, as well as the total test, in terms of what each measured and the kind of educational objectives it assessed. These tests are shown in Appendix F.

Drawing test. The 18-item drawing test (recall measure) presented the students with a list of terms which corresponded to the parts of the human heart discussed in the instructional booklet. The student was required to draw a diagram representing the heart and place the numbers of the listed parts in the proper positions or locations. This test evaluated student learning of specific locations of the parts of the heart, not the quality of the drawing.

Identification test. This 20-item multiple-choice test (recognition measure) required the students to identify the numbered parts on a

detailed drawing of the human heart. Each part of the heart discussed in the instructional booklet was numbered on the drawing and appeared in a list on the answer sheet. Students were required to look at the detailed drawing and select the correct answer for each multiple-choice item. This test measured the student's ability to recognize, identify, and associate specific parts of the heart with their correct labels.

Terminology test. This 20-item multiple choice test (recall and recognition measure) was designed to measure the student's knowledge and ability to recall and recognize specific facts, definitions, and terms regarding the human heart. This test was slightly modified from Dwyer's original by making the number of recall and recognition questions equal. The modification involved converting 10 of the 20 items to fill-in questions and keeping the other 10 items as multiple-choice items. The selection of the 10 items modified was random.

Comprehension test. In this 20-item multiple-choice (recall and recognition measure),

the students were given the location of certain parts of the human heart at a particular moment of its functioning and were asked to identify the position that other specified parts of the heart would be occupying at the same point in time. This test required that the student have a thorough understanding of the heart, its parts, its internal processes, and processes occurring during the systolic and diastolic phases. This test was designed to measure the type of learning that occurs when the individual comprehends what is being communicated and can use the information being received to explain some other phenomenon occurring simultaneously. This test was modified from Dwyer's original by making the number of recall and recognition questions equal in the same way as the terminology test.

Total test. The scores obtained on the four individual tests used were combined into a 78-item total test. This yielded a global score designed to measure the student's total understanding and ability to retain content material.

The students received the drawing test first,

then the identification and terminology tests, and lastly, the comprehension test. Each of them was permitted to take as much time as needed to complete one test before proceeding to the next.

According to Dwyer (1978), the validity of these individual criterion tests was based on the correspondence between the content material in the instructional booklet and the content measured by the different test items. The verbal versions of the criterion tests have been used with more than 40,000 university and high school students. Furthermore, the Kuder-Richardson Formula 20 Reliability coefficient for each test was computed by Dwyer to determine reliability. The average reliability coefficients for each test were .83 for the terminology test, .81 for the identification test, .83 for the drawing test, .77 for the comprehension test, and .92 for the total test. Each of these four tests were also found to be highly correlated with the total test ($\underline{r}$ = .86 for the drawing test, $\underline{r}$ = .80 for the identification test, $\underline{r}$ = .83 for the terminology test, and $\underline{r}$ = .75 for the comprehension test).

All phases in the experimental procedure with the participant were done in one setting (Psychology building Room 118) in order to control for setting effects on memory. Exposure to each experimental condition was done in a group for each experimental condition. Each participant was also screened regarding their knowledge of anatomy, particularly that of the human heart, by asking them whether they had taken college courses in anatomy or physiology or were very knowledgeable about the parts and functions of the human heart. A total of 16 students with prior knowledge were allowed to participate in the experiment, however, their tests were not used in the data analysis of this study to maximize homogeneity of subjects across groups.

Completion of the reading of the instructional material involved instructing the participants not to reread or relisten to the material. Each participant was only allowed to interact with the material once. The answering of the tests, however, was self-paced with no time limits. The students underwent the same test twice to measure

immediate and delayed retention of information. The delayed testing was administered 1 week after the immediate testing.

The specific procedural steps in the data collection phase of this study were as follows:

1. Permission was asked from the psychology faculty to recruit participants from their classes. A letter of permission was sent to the professors concerned (See Appendix G). Potential participants were encouraged to join the study by pointing out the benefits that this research offers for them (e.g., extra credit points in class, personal enrichment, being able to contribute to psychological and educational research).

2. The list of participants was finalized and each student was randomly assigned (with replacement) to the treatment groups. The process of randomly assigning (with replacement) each participant was done by first assigning 5 students regardless of sex to each condition. Participants whose schedule conflicted with that of other participants as well as the experimenter's schedule were replaced and reassigned to another group. At

least 7 participants were scheduled for each experimental group to control for experimental mortality and for anatomy/physiology preknowledge.

3. A schedule was set up to administer the experiment to the students belonging to each of the 18 experimental groups. Treatment and testing were done by experimental group. The schedules for administering the tests was based on the availability of both the students and the administrating experimenter.

4. The students were informed by verbally reminding them and giving them a written notice of the time and place of the experiment for which they were scheduled. To get them to arrive on time, I asked them to come 10 min before the start of the scheduled testing.

5. Before starting the experimental treatment, rapport was established with the participants, by making them feel comfortable and briefly explaining the things the participants needed to know about the experiment. I used an appropriate instructional script which contained information to persuade students in a particular experimental

group regarding the assigned level of preconceived difficulty of the material (see Appendix H).

6. Administration of the experimental condition:

(a) All materials needed for that experimental condition were presented upon their arrival (e.g., instructional booklets, audio tapes, other audio equipment).

(b) They were handed the appropriate instructional booklet and/or audio tape to read and/or listen to. The experimenter reiterated the presupposed degree of difficulty of the particular instructional booklet depending on the specified experimental condition through the use of the corresponding instructional script.

(c) When a participant finished reading or listening to the material, the individual tests were given separately in the following sequence: drawing test, identification test, terminology test, and lastly, the comprehension test. A test must have been completed and returned to the experimenter before the next test was given. This was done for each participant in all the

experimental conditions.

(d) Upon completion of all the tests, the participants were reminded of their next schedule for testing which was 1 week from the date of the first testing session. They were cautioned not to discuss the experiment with anyone. The participants were also informed that their test scores would be privately revealed to them after completing both the first testing (immediate measure) and the second testing (delayed measure). Moreover, they were reminded that they would only receive their extra credit points in class upon completion of both testing sessions and that a list of those students who have fully complied with the requirements of the experiment would be supplied to their professor.

(e) The experimenter thanked the students for participating.

Results

This chapter is divided into three main parts: (1) a univariate split-plot analysis of the total scores across the four tests, (2) two multivariate

analyses of the four immediate tests and four delayed tests, and (3) four univariate split-plot analyses of each of the four memory tests (drawing, identification, terminology, and comprehension). The independent variables considered for each analysis were mode of presentation (print-only, pictorial-plus-print, audio-only, pictorial-plus-audio, print-plus-audio, and pictorial-plus-print-plus-audio) and preconceived degree of difficulty (easy, neutral, and difficult). The dependent variables were the student's total score (the sum of scores on the four memory tests) as well as the scores on each memory test. An alpha level of .05 was used for each analysis.

Data Screening

Split-plot ANOVA. Data screening was done by running the CONDESCRIPTIVE and MANOVA procedures for analyzing data using the SPSS-X system. The dependent variable was the total scores across all four tests. The repeated measures (within-group) variable was the immediate and delayed test times. Total N = 112 and the results of evaluations of the assumptions of normality (skew with criterion of z

$\geq \pm 3.0$), and homogeneity of variance (Bartlett-Box *F* with criterion of .01 level of significance) were satisfactory. There were no univariate outliers (criterion = $z \geq \pm 3.0$). Initial evaluation of the data indicated lack of support for the multisample circularity (sphericity) assumption (Bartlett's test of sphericity with the criterion of .01, SPSS-X MANOVA of the total immediate and of total delayed scores) but since the number of levels of the repeated measures variable was only two, the apparent failure of multisample circularity has no effect on the *F* test. These same procedures were used to evaluate the assumptions for the split-plot analyses of each of the four memory tests (i.e., drawing, identification, terminology, and comprehension). Total *N* = 112 and the results of evaluation of all assumptions for each test were found to be satisfactory. There were no univariate outliers.

MANOVA for immediate and delayed tests. The SPSS-X system was also used in evaluating the data used for the separate immediate and delayed MANOVA runs in which the dependent variables were the

separate scores on the drawing, identification, terminology, and comprehension tests. Additional runs for data screening were the REGRESSION and PLOT procedures. For the univariate tests of assumptions done separately on the immediate and delayed tests, total N = 112 and the results of evaluating the univariate assumptions of normality (skew with criterion of $z \geq \pm 3.0$), and homogeneity (Bartlett-Box F with criterion of .01) were found to be satisfactory. There were no univariate outliers (criterion = $z \geq \pm 3.0$). Multivariate normality was assumed to be satisfied given the nature of the dependent measures of memory. Tests of the multivariate assumptions of linearity (visual inspection of bivariate scatterplots of all pairs of dependent variables using SPSS-X PLOT procedure) and multicollinearity/singularity ($R^2 > .98$) of the immediate and delayed tests were satisfactory. Using the SPSS-X REGRESSION analysis procedure with each dependent measure in turn serving as the predicted variable, multivariate outliers were located and deleted before a MANOVA with all multivariate assumptions satisfied was

done. A total of 12 outliers were detected during five runs of the Regression analysis leaving a total N = 100 for the two MANOVAs with the screened data.

Univariate Split-Plot Analysis of The Total Score

A 6 x 3 x 2 split-plot analysis of variance (SPF-63.2, Kirk, 1982) was performed on the immediate and delayed total scores across all four tests. SPSS-X MANOVA procedure was used for the analysis.

Table 1 shows that the main effects of mode of presentation and preconceived degree of difficulty were both significant. There were no significant interaction effects and no significant repeated measures effects.

Table 1

Summary Table For Split-Plot ANOVA of Total Scores

Source of Variation	SS	df	MS	F
Mode	6720.88	5	1344.18	3.93*
PDD	2544.98	2	1272.49	3.72*
Mode x PDD	4613.26	10	461.33	1.35
Subjects w. Mode x PDD	32166.90	94	342.20	
Time	67.45	1	67.45	3.63
Mode x Time	33.97	5	6.97	--
PDD x Time	35.15	2	17.58	--
Mode x PDD x Time	65.60	10	6.56	--
Time x Subjects w. Mode x PDD	1746.55	94	18.58	

*$p < .05$

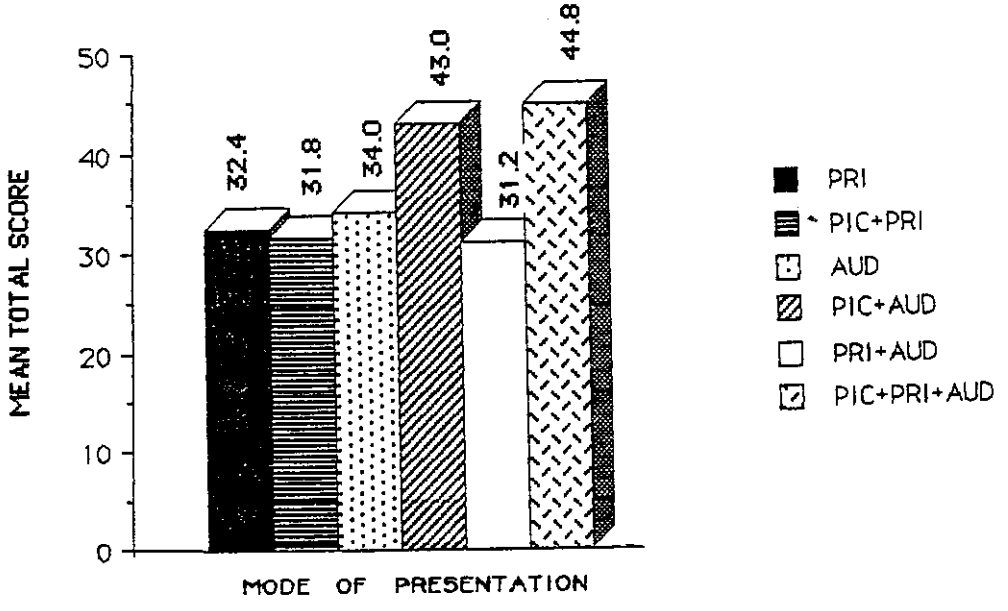


Figure 3. Bar graph of means for mode of presentation (total scores averaged across immediate and delayed test times).

The Dunn-Sidak (a priori nonorthogonal contrast) multiple comparison procedure was used to test each of the predictions. A .05 level of significance was used for the group of four one-tailed predictions (i.e., that bimodal presentations that involved pictures would be significantly superior to any of the single mode presentations). None were significant. For the three two-tailed predictions (i.e., that any of the bimodal presentation means would not significantly differ from the triple-mode mean) equivalent to predicting a null hypothesis, the probability of a Type I error was increased to .25 to increase the power for each test. Contrary to the prediction, the pictorial-plus-print-plus-audio mode mean was significantly superior (at alpha = .25) to the pictorial-plus-print mode mean and the print-plus-audio mode mean. The one other comparison was not significant (pictorial-plus-print-plus-audio mean = pictorial-plus-audio mean). The Tukey-Kramer (a posteriori) multiple comparison test using a .05 level of significance showed that none of the pairwise comparisons of means for mode of

presentation were significant.

The Tukey-Kramer a posteriori multiple comparison test of all mean differences at the .05 protection level indicated no significant mean difference between the easy, neutral, and difficult conditions. The total score means for preconceived degree of difficulty were 40.0 for the easy condition, 36.4 for the neutral condition, and 31.5 for the difficult condition.

Multivariate Analysis of The Immediate And Delayed tests

Separate 6 x 3 MANOVAs (SPSS-X MANOVA procedure) were performed for the immediate tests and the delayed tests using the drawing, identification, terminology, and comprehension tests as the dependent variables. The data sets with multivariate outliers (N = 112) and without multivariate outliers (N = 100) were both analyzed and the results are presented in this section for the immediate and delayed tests.

Immediate tests. For both data with and without outliers, the combined dependent variables were significantly affected by the mode of

presentation, but not by preconceived degree of difficulty, and not by their interaction (Tables 2 and 3). The major factors contributing to the significant effect of mode were the immediate drawing test, univariate $F(5, 94) = 3.67$ (with outliers), $F(5, 82) = 3.54$ (without outliers), $p < .01$, and the immediate identification test, univariate $F(5, 94) = 8.78$ (with outliers), $F(5, 82) = 6.94$ (without outliers), $p < .001$. According to the univariate analyses, the immediate tests of terminology and comprehension each did not make a significant independent contribution to the significant main effect of the mode of presentation for immediate testing on retention.

Table 2

Summary Table For 6 x 3 MANOVA For Immediate Tests (with outliers, $N = 112$)

Source	Wilks' lambda	Approx. F	Hyp. df	Error df
Mode	0.56	2.87*	20	303
PDD	0.87	1.69	8	182
Mode x PDD	0.70	--	40	347

*$p < .001$

Table 3

Summary Table For 6 x 3 MANOVA For Immediate Tests (without outliers, N = 100)

Source	Wilks' lambda	Approx. F	Hyp. df	Error df
Mode	0.56	2.48*	20	263
PDD	0.83	1.94	8	158
Mode x PDD	0.61	1.03	40	301

*p < .001

Delayed tests. For both data with and without outliers, the combined dependent variables were also significantly affected by the main effect of mode, but not by preconceived degree of difficulty, and not by their interaction (Tables 4 and 5). Similar to the univariate findings of the MANOVA for the immediate tests, the delayed drawing test, univariate mode $F(5, 94) = 5.0$ (with outliers), $F(5, 82) = 4.48$ (without outliers), $p < .001$, and the delayed identification test, univariate mode $F(5, 94) = 5.47$ (with outliers), $F(5, 82) = 4.11$ (without outliers), $p < .01$, were determined to be the major independent contributors to the significant effect of mode of presentation

on the retention of content material for delayed testing.

Table 4

Summary Table For 6 x 3 MANOVA For Delayed Tests (with outliers, N = 112)

Source	Wilks' lambda	Approx. F	Hyp. df	Error df
Mode	0.64	2.21*	20	303
PDD	0.90	1.24	8	182
Mode x PDD	0.64	1.09	40	347

*p < .01

Table 5

Summary Table For 6 x 3 MANOVA For Delayed Tests (without outliers, N = 100)

Source	Wilks' Lambda	Approx. F	Hyp. df	Error df
Mode	0.62	2.01*	20	263
PDD	0.84	1.75	8	158
Mode x PDD	0.63	--	40	301

*p < .01

Univariate Split-Plot Analysis Of Each Memory Test.

A 6 x 3 x 2 split-plot ANOVA was performed on the scores for each of the four tests used. The SPSS-X MANOVA procedure was used for each analysis.

Drawing test. Table 6 shows a significant main effect for mode of presentation but no significant main effect of preconceived degree of difficulty. There was no significant interaction effect between mode of presentation and preconceived degree of difficulty. Moreover, the repeated measures effect (immediate and delayed test time) was found to be significant. The immediate and delayed score means were 7.7 and 8.1, respectively. The interactions between preconceived degree of difficulty and time, and between mode, preconceived degree of difficulty, and time, were both determined to be significant. All other interactions with time were nonsignificant.

Table 6

Summary Table For 6 x 3 x 2 Split-Plot ANOVA For Drawing Test

Source of Variation	SS	df	MS	F
Mode	857.42	5	171.48	4.75*
PDD	214.98	2	107.49	2.98
Mode x PDD	348.71	10	34.87	--
Subjects w. groups	3393.33	94	36.10	
Time	22.96	1	22.96	5.83*
Mode x Time	13.61	5	2.72	--
PDD x Time	35.11	2	17.56	4.46*
Mode x PDD x Time	91.39	10	9.14	2.32*
Time x Subject w. Mode x PDD	369.90	94	3.94	

*$p < .05$

The Tukey-Kramer a posteriori multiple comparison procedure, using a .05 protection level, showed that none of the pairwise comparisons for mode of presentation means were significant. The mode of presentation means across immediate and delayed tests were 6.3 for the print-only mode, 6.6 for the pictorial-plus-print mode, 7.0 for the audio-only mode, 10.4 for the pictorial-plus-audio

mode, 6.2 for the print-plus-audio mode, and 11.0 for the pictorial-plus-print-plus-audio mode.

The Gabriel's simultaneous test procedure was used in the a posteriori contrast-contrast analysis of the significant omnibus PDD x Time interaction (See Figure 4). A visual inspection of the slopes suggested separate comparisons of the mean difference of the easy condition (-0.4) and the difficult condition (0.4) with the neutral condition (1.6). It was determined that there were significant differences (protection level = .05) between the easy condition mean difference and neutral condition mean difference, and between the neutral condition mean difference and the difficult condition mean difference. Figure 5 is a graph of the immediate and delayed mean scores of the 18 groups of the significant Mode x PDD X Time interaction. This graph does not show any clear meaningful trends so no further analysis was done of the significant interaction effect.

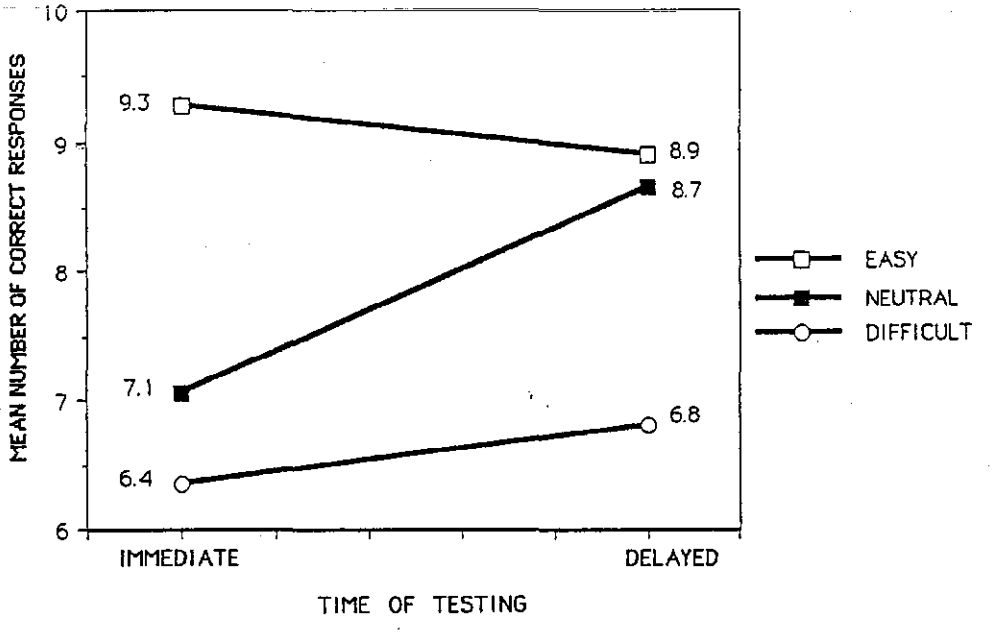


Figure 4. Line graph of means for PDD x Time Interaction (Drawing Test).

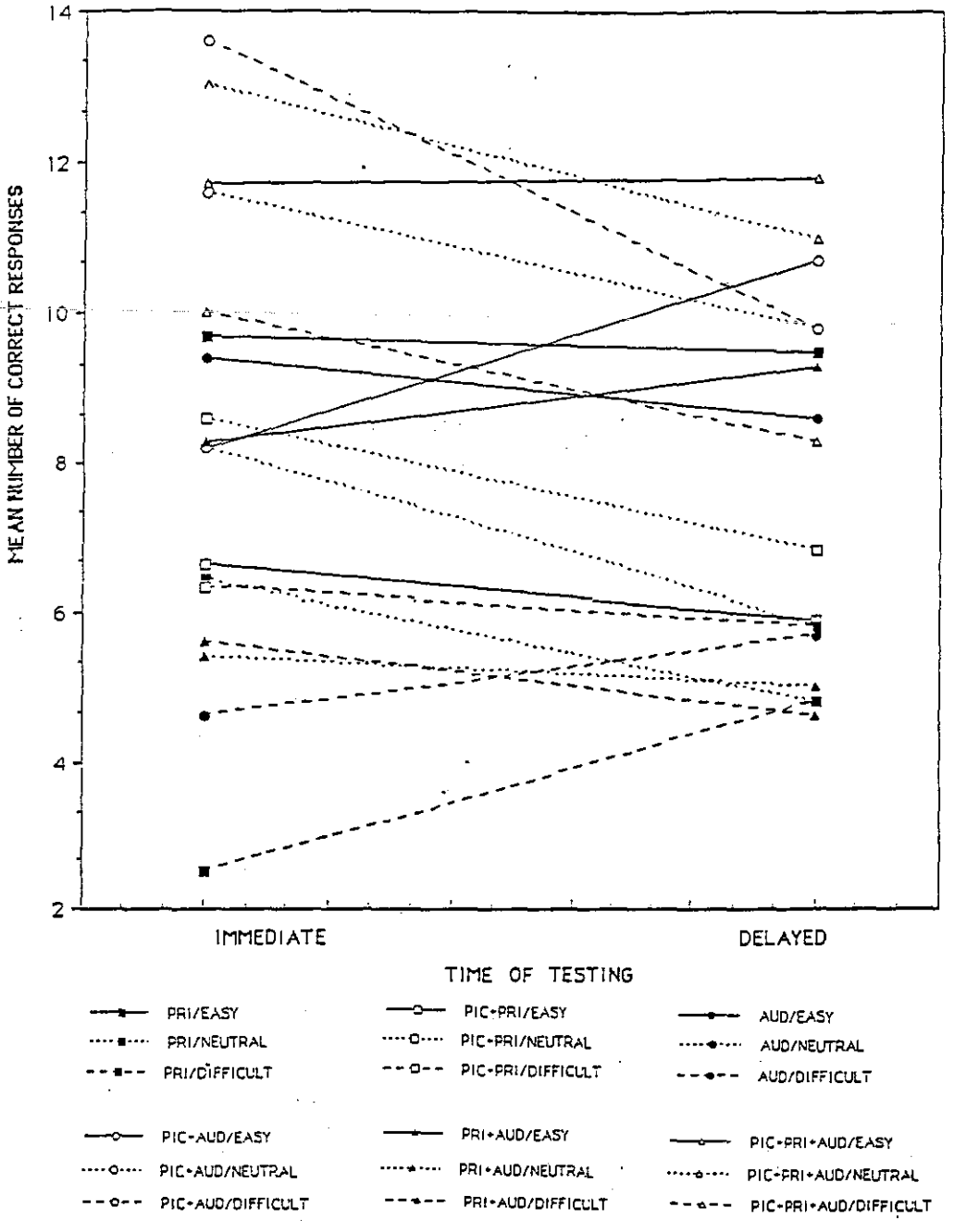


Figure 5. Line graph of drawing test score means for Mode x PDD x Time Interaction (18 groups).

Identification test. Table 7 shows that there were significant main effects for mode of presentation and preconceived degree of difficulty. The interaction between mode and time was also significant. All other effects were not significant.

Table 7

Summary Table For 6 x 3 x 2 Split-Plot ANOVA For Identification Test

Source of Variation	SS	df	MS	F
Mode	1053.83	5	210.77	7.73*
PDD	210.09	2	100.54	3.69*
Mode x PDD	321.97	10	32.20	1.18
Subjects w. groups	2562.75	94	27.26	
Time	10.03	1	10.03	2.57
Mode x Time	52.04	5	10.41	2.66*
PDD x Time	5.99	2	2.99	--
Mode x PDD x Time	35.18	10	3.52	--
Time x Subject w. Mode x PDD	367.32	94	3.91	

*$p < .05$

The Tukey-Kramer a posteriori multiple comparison procedure showed that the pictorial-plus-audio and the pictorial-plus-print-plus-audio means were significantly superior to the audio-only mean at the .05 protection level (See Figure 6). No other comparisons for mode were found to be significant. The Tukey-Kramer procedure yielded no significant differences in the pairwise comparisons of means for the easy, neutral, and difficult conditions. The identification test score means for preconceived degree of difficulty were 11.8, 10.5, and 9.2 for the easy, neutral, and difficult conditions, respectively.

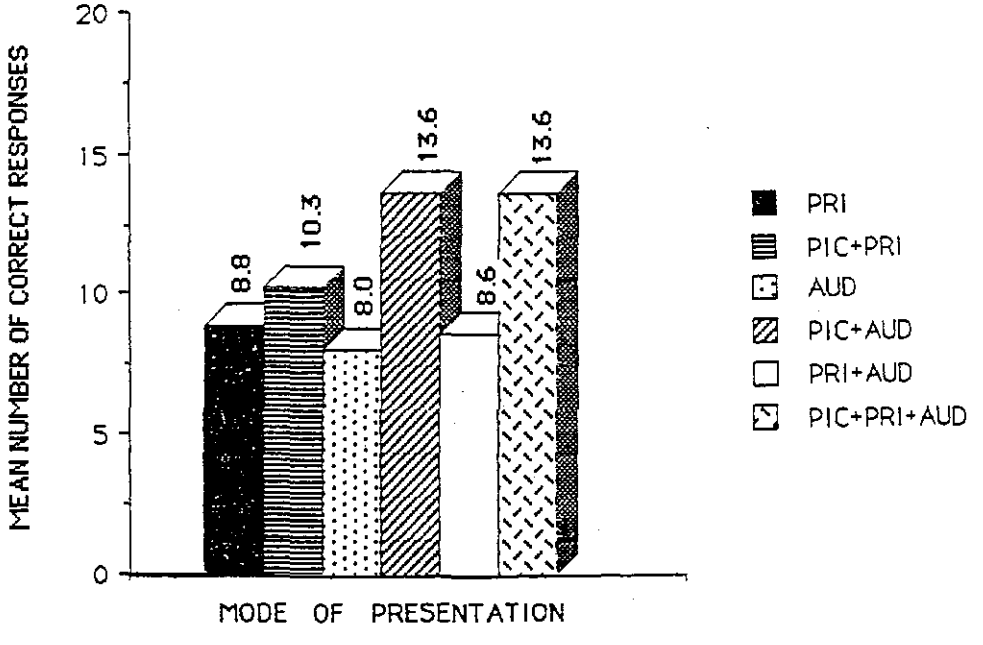


Figure 6. Bar graph of means for mode of presentation (Identification Test means across immediate and delayed tests).

The Gabriel's simultaneous test procedure was used with a posteriori contrast-contrast comparisons to analyze the significant Mode x Time interaction (See Figure 7). A visual inspection of the slopes suggested a comparison of the mean difference of print-only (2.5) with the mean differences of the other modes (i.e., 0.1 for pictorial-plus-print, 0.6 for audio-only, 0.6 for pictorial-plus-audio, 0.9 for print-plus-audio, and 0.4 for pictorial-plus-print-plus-audio). Results indicated that there was no significant difference (protection level = .05) between the print-only mode mean difference and the other mode mean differences with respect to the Mode x Time interaction.

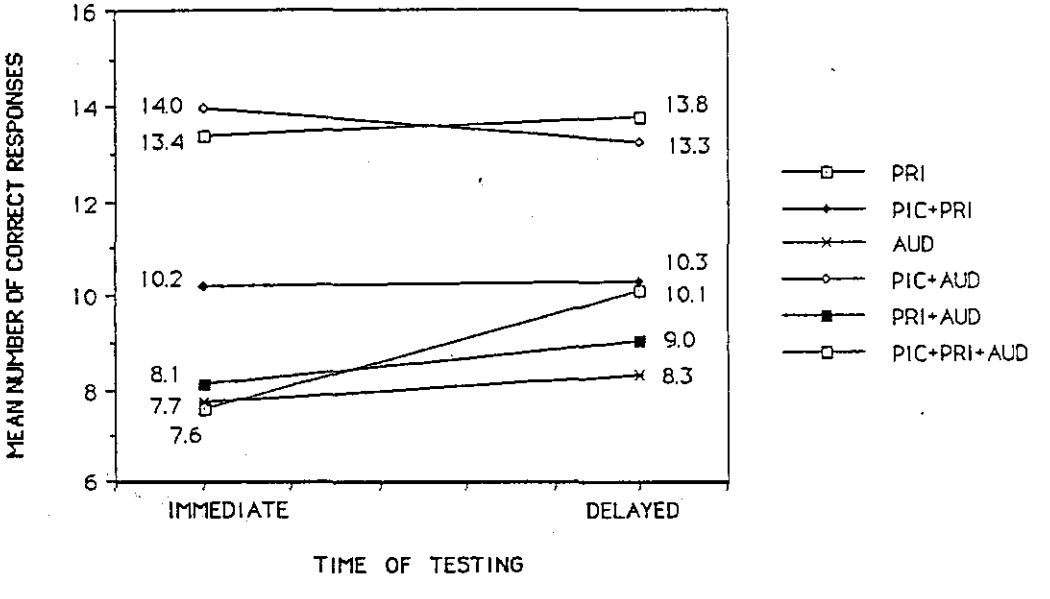


Figure 7. Line graph of means for Mode x Time (Identification Test).

Terminology test. A 6 x 3 x 2 split-plot ANOVA was performed on the immediate and delayed terminology test scores. There were no significant main or interaction effects (Table 8).

Table 8

Summary Table For 6 x 3 x 2 Split-Plot ANOVA For Terminology Test

Source of Variation	SS	df	MS	F
Mode	284.28	5	56.86	1.6
PDD	149.21	2	74.60	2.1
Mode x PDD	441.88	10	44.19	1.24
Subjects w. groups	3347.35	94	35.61	
Time	7.54	1	7.54	2.26
Mode x Time	7.19	5	1.44	--
PDD x Time	3.72	2	1.86	--
Mode x PDD x Time	51.74	10	5.17	1.55
Time x Subject w. Mode x PDD	313.81	94	3.34	

Comprehension test. A 6 x 3 x 2 split-plot ANOVA was performed on the immediate and delayed comprehension test scores. There were no significant main or interaction effects (Table 9).

Table 9

Summary Table For 6 x 3 x 2 Split-Plot ANOVA For Comprehension Test

Source of Variation	SS	df	MS	F
Mode	135.65	5	27.13	1.46
PDD	101.81	2	50.91	2.74
Mode x PDD	186.48	10	18.65	1.00
Subjects w. groups	1747.22	94	18.59	
Time	6.48	1	6.48	2.47
Mode x Time	13.42	5	2.68	1.02
PDD x Time	7.44	2	3.72	1.42
Mode x PDD x Time	34.79	10	3.48	1.32
Time x Subject w. Mode x PDD	246.96	94	2.63	

Discussion

Univariate Split-Plot ANOVA of Total Score

Overall, the results differed from what was originally hypothesized. Regarding the effect of mode of presentation, there was a significant effect but it was not in the direction expected based on the literature reviewed. All one-tailed predictions (i.e., that the bimodal presentations

involving pictures would be significantly superior to any of the single mode presentations) and two of the three two-tailed predictions (i.e., that any of the bimodal presentations would not significantly differ from the pictorial-plus-print-plus-audio mode) were not supported. The only prediction that was supported by the data was the two-tailed prediction of no significant difference between the pictorial-plus-print-plus-audio mean and the pictorial-plus-audio mean.

The mode of presentation means for the total score showed very little mean difference between the print-only, audio-only, pictorial-plus-print, and print-plus-audio modes (see Figure 3). In contrast, the pictorial-plus-audio mode condition and the triple-mode condition both showed higher mean scores than the single modes and the two other bimodal modes, although they were not significantly higher.

The major procedural difference between Dwyer and De Melo's (1984) study and my study was that the former did not control for frequency of presentation for the 151 undergraduate

participants. The results of their study showed that the bimodal version (printed prose complemented by simple line drawings) of the instructional unit significantly improved the students' retention of the material as measured by the identification, terminology, and comprehension tests as well as the total of these three tests. All the three tests showed that the pictorial-plus-print version of the content material was significantly superior to the print-only version. Contrary to this finding, the present study found no significant difference between the pictorial-plus-print mode and the print-only mode. It was possible that the procedural aspect of having instructed the participants not to reread the material in the present study put more pressure on them and may have increased the difficulty in the encoding of the printed material. The point in controlling for frequency of presentation was to see which mode was more effective regardless of time on task. The absence of the drawing test in the computation of Dwyer and De Melo's total score may have also contributed to the differing results.

In a similar study by Joseph and Dwyer (1984) the same instructional unit (i.e., the heart and its functions) was used for 414 tenth grade public school students enrolled in mandatory health classes. It was found that for the total score analysis of the data from those with medium prior knowledge, externally-paced presentations (i.e., one form of pictorial-plus-print-plus-audio) was significantly superior to the print-plus-audio condition, however, the three other modes of pictorial presentation were not superior to the no-picture condition. Moreover, there were no significant differences for any of the low prior knowledge conditions. The present study found no significant differences between any mode means in the total score analysis. It was possible that the difference in population studied (i.e., tenth graders versus undergraduates) may account for the difference in the results or that the one significant finding in Joseph and Dwyer's study is not replicable.

Exceptions to the hypothesized superiority of a bimodal presentation of iconic and/or linguistic

codes were that the pictorial-plus-print, pictorial-plus-audio, and print-plus-audio means were not significantly superior to the print-only and audio-only means. These results not only contradict the theoretical framework, but also existing research demonstrating the effectiveness of pictorial augmentation of print (Dwyer & De Melo, 1984; Goldberg, 1974; Haring & Fry, 1979; Joseph & Dwyer, 1984; Peeck, 1974).

Preconceived degree of difficulty was found to be significant in the univariate split-plot ANOVA of the total score. The means for preconceived degree of difficulty were ordered such that the more difficult the content material was perceived, the lesser the ability to retain such material. None of the pairwise comparisons of means were found to be significant, however, if an a priori linear trend had been predicted, the data would have supported such a prediction. It is possible that preconceived degree of difficulty is an important cognitive variable that can have considerable influence on encoding, but the method of verbal persuasion used in this study did not

make enough impact. Verbal persuasion is a flexible and readily available method to induce the variable of preconceived degree of difficulty, although better ways of enhancing its impact should be explored along with different methods of inducing motivational state as well (e.g., vicarious experience or physiological state).

Multivariate Analysis of Immediate and Delayed Tests

Results showed that for both the immediate and delayed tests, the tests mostly contributing to the significant effect of mode on the retention of content material were the drawing and identification tests. This finding was true for the MANOVA analyses with the outliers and without the outliers. The drawing test (fill-in questions) evaluated student learning of specific locations of the parts of the heart, while the identification test (multiple-choice questions) measured the student's ability to recognize, identify, and associate specific parts of the heart with their correct labels. The terminology test (fill-in and multiple-choice questions) was designed to measure

the student's knowledge and ability to recall and recognize specific facts, definitions, and terms regarding the human heart while the comprehension test (fill-in and multiple-choice questions) was designed to measure the type of learning that occurs when the student comprehends the material and can use the information being received to explain some other phenomenon occuring simultaneously (e.g., systolic and diastolic processes). The drawing (recall measure) and identification (recognition measure) tests require a more basic understanding of the content material. Simple memorization of the material presented is sufficient for a student to be able to answer the items correctly since the questions focused more on the identification and location of the parts of the human heart. On the other hand, the terminology and comprehension tests required a more thorough understanding of both the parts and functions of the human heart. Simple memorization of the parts of the human heart and their locations is necessary but not sufficient to be able to answer the items correctly since the questions dealt more on the

roles of the various parts of the heart in the systolic and diastolic functions.

For both the immediate and delayed tests, the terminology and comprehension tests, both of which were the tests modified from Dwyer's original to make the number of recall and recognition items more equal, did not show a significant effect of the mode of presentation. For each of these tests, the modification involved the conversion of 10 randomly selected items of the 20 items to fill-in questions while keeping the rest as multiple-choice items. However, the mean scores for the four tests were similar, 7.9 for the drawing test (44% correct), 10.6 for the identification test (53% correct), 8.5 for the terminology test (42% correct), and 9.2 for the comprehension test (46% correct).

Since the students were unfamiliar with this type of material (i.e., parts and functions of the human heart), most of them performed poorly. Out of a possible perfect total score of 78 points, the grand total mean was 36.2 (46% correct).

The presence of a significant main effect in the analysis of the drawing and identification tests suggests that these two tests might be structured more appropriately for the content material than the terminology and comprehension tests. The content material (i.e., the heart and its functions) has a highly visual character for most people and the drawing and identification tests both dealt with locating parts within a visual depiction of the human heart. The other two tests were more abstract in character. This approach to understanding the results suggests that if the objective of instruction had been carefully specified at the outset with a coordinate selection of content material and memory tests to match the instructional objectives, then instructional modes that most closely matched the instructional objective and memory tests would have more clearly and reliably facilitated retention and recall of the material.

Univariate Split-Plot Analysis of Each Memory Test

Among the four tests used to measure retention of content material, only the drawing test and the

identification test yielded significant results.

For the drawing test, the mode of presentation had a significant main effect on retention but no significant pairwise comparisons of means were found. In the study by Joseph and Dwyer (1984), the main effect of pacing was significant such that externally-paced modes (i.e., four forms of pictorial-plus-print-plus-audio; print-plus-audio) were generally superior to the self-paced modes (i.e., four forms of pictorial-plus-print; print-only) in the drawing test. The analysis of the interaction of time and preconceived degree of difficulty for my data showed that both the easy and difficult conditions were significantly different from the neutral condition. There was a tendency for people who perceived the instructional material as neutral to improve their drawing score from the immediate to delayed tests while those who perceived it to be easy or difficult showed little change. No explanation to this phenomenon can be inferred from previous studies or developed by rational analysis.

For the identification test, both the mode of

presentation and preconceived degree of difficulty were found to be significant although there were no significant mean differences for preconceived degree of difficulty. The students' ability to recognize, identify, and specify parts of the heart with their correct labels, was enhanced by the pictorial-plus-audio and pictorial-plus-print-plus-audio modes relative to the audio-only mode. This is consistent with Joseph and Dwyer's (1984) study which found that bimodal presentations that involved pictures were generally better than nonpictorial presentations for the drawing and identification tests.

Similar to my study, no significant results for presentation mode were found for both the terminology and comprehension tests in the study by Joseph and Dwyer (1984).

Summary of Significant Results

In summary, results for the univariate split-plot ANOVA of the total score showed that the main effects of mode and preconceived degree of difficulty were found to be significant. However, only one prediction was supported--the hypothesis

of no difference between the triple-mode condition and the pictorial-plus-audio mode condition. No significant mean differences between the easy, neutral, and difficult conditions were found. For the multivariate analyses of the immediate and delayed tests, univariate analyses showed that the drawing and identification tests, for both the immediate and delayed testing, were the major independent contributors to the significant effect of mode of presentation on the retention of content material. In the univariate split-plot analysis of the drawing test, none of the pairwise comparisons for mode of presentation means were significant. The univariate split-plot analysis of the identification test showed that the pictorial-plus-audio mode and the triple-mode means were significantly superior to the audio-only mode and not significantly different from each other. In summary, with this one exception, results of this study did not provide a refinement of the idea that "the more media channels used, the better."

Recommendations

This section suggests some recommendations to

improve the present study and possible issues to consider for future related research topics.

Further investigation should be made on possible effects of controlling for time on task versus controlling for frequency of presentation of the material. Controlling for frequency of presentation limits the number of times the participants were allowed to encode or review the instructional material in the encoding process. On the other hand, controlling for time on task (e.g., Carey & Hannafin, 1981; Goldberg, 1974; Hannafin, 1983; Hannafin, 1984) limits the amount of time in which a participant is able to encode the material regardless of the number of times the subject is able to encode or review the material. The possible effect of controlling frequency of presentation is that some learners are not able to effectively encode material for the first presentation. In other words, the number of times the content material need to be presented for effective encoding in memory varies greatly from person to person. Nonetheless, in order to objectively compare the encoding properties of each

mode, frequency of presentation was controlled by presenting the material only once for all modes of presentation. Time on task for all print conditions (without audio) was controlled by the participants in the present study. Controlling for time on task takes into account how efficiently a learner is able to encode the material given that the learner has more control over the number of times the material is reviewed over a period of time. In the typical studying situation, most students study by encoding material given a specified period of time; that is, they control for time on task, not frequency of presentation. Therefore, controlling for time on task may be more representative of a student's studying process.

Future related studies may increase the number of participants to at least 20 subjects per cell to improve the reliability of the study. Although the current study had $\underline{N}$ = 112, the number of participants in each experimental condition ranged only from 5 to 9 subjects.

It is highly probable that the participants' attitudes and motivation affected their retention

of the instructional material. In this study, most participants (i.e., psychology students) may not have considered the content material meaningful. The majority of the subjects participated in the experiment for the purpose of receiving extra credit points from their psychology classes; credit was earned regardless of how they performed on the memory tests. Thus, the possible lack of motivation to learn the content material may have confounded the results. This could be controlled by blocking the participants on these "motivational factors" (i.e., evaluation of the subjects' motivational level towards the content material prior to the presentation of the instructional material).

As part of the continuing search to understand how the human memory functions, there is a need for further research to define more closely the unique blend of symbol systems (i.e., iconic and linguistic) that characterizes various media and to determine how each symbol system can be used most effectively--singly and/or in combination--to promote learning. There are many different types

of pictorial aids possible, the various kinds of pictures and their functions within particular instructional contexts should be examined, as well as the types of information, objectives, and content conducive to pictorial presentation. Pictorial realism continuums have received considerable research attention (Dwyer, 1978), but other areas of pictorial characteristics need to be explored to help give educators useful tools in enhancing the learner's memory abilities. Picture size, color, and position, especially as used with print, are potential research variables.

Other ways to induce preconceived degree of difficulty as an independent variable may be researched such as vicarious experience (i.e., observing others perform a task sucessfully or unsuccessfully), enactive attainments (i.e., being affected by one's own past successes or failures), and physiological state (i.e., judging one's capabilities based on physiological arousal in taxing situations) to be able to compare their efficiency and effectiveness in the retention of content material. This could provide crucial

information on how preconceived degree of difficulty can be more effectively manipulated as an independent variable.

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Appendix A

Instructional Script

The Heart and Its Functions

The human heart is a hollow, bluntly conical, conical, muscular organ. Its pumping action provides the force that circulates the blood through the body. In the average adult, the heart is about five inches long and about two and one half inches thick. A man's heart weighs about eleven ounces and a woman's heart weighs about nine ounces. The heart lies toward the front of the body and is in a slanting position between the lungs, immediately below the breastbone. The wide end points toward the right shoulder. The small end of the heart points downward to the front of the chest and toward the left. The lower portion of the heart is called the apex and is the part that you feel beating.

In order to better comprehend the following instruction, it will be helpful to visualize a cross-section view of a human heart in a position such that you are facing the person. As you visualize it, the right side of the heart will be

on the left side.

To understand the functioning of the heart, you will be able to identify the parts of the heart. The heart is enclosed in a thin double-walled sac. The layer which forms the outer wall of the sac is called the pericardium. It is composed of a tough, transparent, elastic tissue. It protects the heart from rubbing against the lungs and the walls of the chest. The inner portion of the double walled sac is called the epicardium. It is attached to the heart muscle.

The heart muscle is called the myocardium; it controls the contraction and relaxation of the heart. The myocardium constitutes by far the greatest volume of the heart and its contraction is responsible for the propulsion of the blood throughout the body. The myocardium varies in thickness. For example, the myocardium forming the auricle walls is thin when compared to the thickness of the myocardium forming the ventricle walls.

The endocardium is the name given to the inside lining of the heart wall.

The human heart is really two pumps combined into a single organ which circulates blood to all parts of the body. The heart is divided longitudinally into two halves by the septum. The two halves may be compared to a block of two houses, which are independent of each other but have a common wall, the septum, between them.

Each half of the heart is divided into an upper chamber and a lower chamber; the upper chambers are called auricles and the lower chambers are called ventricles. Although there is no direct communication between the right and left sides of the heart, both sides function simultaneously. As was stated previously, the upper chambers on each side of the septum are auricles, and lower chambers are called ventricles. Auricles have thin walls and act as receiving rooms for the blood while the ventricles below act as pumps, moving the blood away from the heart.

As you would view a cross-sectional diagram of the heart, blood enters the right auricle through veins. Only veins carry blood to the heart. The superior and inferior vena cavas are the two veins

which deposit blood in the right auricle. There are no valves at the openings of these veins into the right auricle from all body parts above heart level, for example, the head and the arms.

The other vein, the inferior vena cava, deposits blood into the right auricle from the trunk and legs, that is, from regions below the heart level. As blood from the body fills the right auricle, some of it begins to drip into the right ventricle immediately.

The auricles and ventricles on each side of the heart communicate with each other through openings. The opening between the right auricle and right ventricle is called the tricuspid valve. This valve consists of three triangular flaps of thin, strong, fibrous tissue. These flaps permit the flow of blood into the right ventricle, but prevent it from flowing backward into the right auricle because the ends of the flaps are anchored to the floor of the right ventricle by slender tendons.

The three flaps act like swinging doors which open only in one direction. Thus, blood passes

from the right auricle through the tricuspid valve into the right ventricle. As soon as the right ventricle is filled with blood, both ventricles begin to contract.

The first effect of the pressure produced in the right ventricle is to force blood behind the flaps of the tricuspid valve.

While the blood pressure behind the flaps brings the flaps together and prevents the flow of blood, the contraction of the right ventricle continues until the blood presses hard enough to open the pulmonary valve and to force the blood into the pulmonary artery. The pulmonary valve is located between the right ventricle and the pulmonary artery.

The pulmonary valve, like the tricuspid valve, consists of three flaps which fill with blood backing up in the pulmonary artery. As soon as the right ventricle begins to relax from its contraction, the pulmonary valve prevents blood from flowing back into the right ventricle from the pulmonary artery. The pulmonary valve opens only when the pressure in the right ventricle is greater

than the pressure in the pulmonary artery, forcing the blood into the pulmonary artery.

The pulmonary valve is composed of flaps or pockets, which the swollen pulmonary artery quickly fill with blood as soon as the right ventricles begins to relax from its contraction. The flaps or pockets of the valve are thus passed together, and no blood flows back into the right ventricle.

After the blood passes through the pulmonary valve, it enters the pulmonary artery from which it is carried up through the heart to both the left and right lungs where it is cleansed and oxygenated.

Returning from the lungs, the blood enters the heart through four pulmonary veins and collects in the left auricle.

Like the right auricle, the left auricle also contracts when it is full, squeezing blood through the mitral valve into the left ventricle. The mitral valve is located between the left auricle and the left ventricle.

The mitral valve is similar in contruction to the tricuspid valve. As the left ventricle

contracts simultaneously with its mate, the right ventricle, it forces blood behind the flaps of the mitral valve, thereby closing the path back to the left auricle.

The contraction of the left ventricle pumps the blood through the entire body. For this reason, it is the largest, strongest, and most muscular section of the heart. When the left ventricle which is filled with blood contracts, the resulting pressure in the ventricle opens the aortic valve located in the mouth of the aorta.

The aorta is the large artery which carries the blood from the left ventricle.

The Circulation of the Blood

The directional flow of the blood in the heart is determined by valves which allow the blood to flow in only one direction.

Both auricles receive blood simulataneously through unguarded openings in the veins. The right auricle receives its blood through the superior and inferior vena cavas while the left auricle receives its blood through the pulmonary veins.

A wave of muscular contraction starts at the top of the heart and passes downward, simultaneously, over both sides of the heart; that is, both auricles contract at the same time and then relax as the contraction passes down to the ventricles. When the auricles are caused to contract, they become small and pale, and in doing so the blood in their chambers is subjected to increased pressure which forces blood through both the tricuspid and mitral valves.

As the ventricles fill, eddies of the blood float the flaps on both the tricuspid and the mitral valves out to a partially closed position.

As the ventricle pressure becomes greater than that in the auricles, the valves are tightly closed and so prevent blood from being forced backward into the auricles.

While the auricles are relaxing from the contraction, blood flows into them from the veins as the contraction of the ventricles is initiated.

The instant that the contraction of the auricles has been completed, the ventricles are stimulated to contract; this contraction increases

the pressure in the chambers forcing the valves, both the tricuspid and mitral, completely shut.

The pulmonary valve and the aortic valve, also called the semi-lunar valves, that guard the entrances to the pulmonary artery on the right and the aortic artery on the left are closed by the back pressure provided by blood already in these vessels. When the ventricle pressure becomes greater than that in the exit vessels, the pulmonary and aortic valves open.

Blood flows from the right ventricles into the pulmonary artery en route to the lungs and from the left ventricle into the aorta for distribution through the entire body.

Immediately following ejection of blood into the arteries, the ventricles begin to relax; this lowers the pressure within their chambers, and the greater pressure in the arteries closes the semi-lunar valves. Pressure within the ventricles is sufficient, however, to maintain closure of the tricuspid and mitral valves against the already increasing auricle pressure.

As the ventricles relax further, pressure

within them decreases correspondingly, and the tricuspid and mitral valves are forced open by increased auricle pressure caused by blood flowing into them from the veins. Therefore, before the next auricle contraction, blood is already flowing from the auricles into the ventricles because a greater blood pressure exists in the auricles than in the ventricles.

The Cycle of the Heartbeat Consists of Two Parts

The relaxation of the ventricles, during which they are filled with blood, is called the diastolic phase.

The heart relaxes between beats in the diastolic phase. Blood flows into the heart filling both auricles. While blood is flowing into the auricles, the recoil of the artery wall still maintains part of the pressure developed by the contraction of the ventricles. This is the time of lowest pressure in the arteries or what is called the diastolic pressure.

The contraction phase or systolic phase begins when the auricles contract. The blood forces its way through the mitral and tricuspid valves into

the ventricles.

The ventricles contract and force the blood through the semi-lunar valves, that is, the pulmonary and aortic valves.

After passing through the pulmonary and aortic valves, the blood enters the pulmonary and aortic arteries. The blood leaves the ventricles under terrific pressure and surges through the arteries with a force so great that it bulges their elastic walls. At this point, arterial blood pressure is greatest; this pressure is called the systolic pressure. The heart relaxes again and the tricuspid and mitral valves close. Blood flows into the auricles; the mitral and tricuspid valves are forced open, and the cycle begins again.

Appendix B

Pictures of the Human Heart

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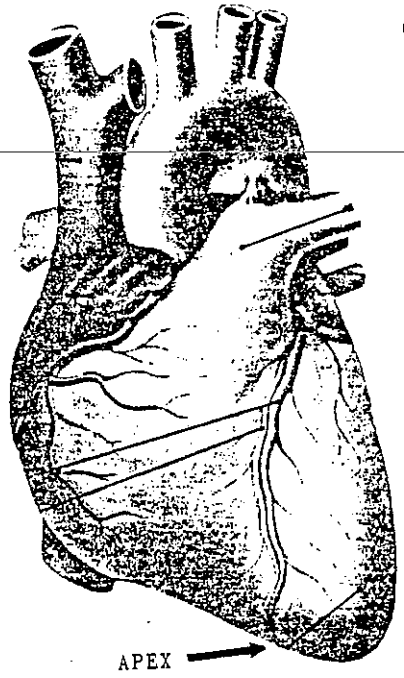

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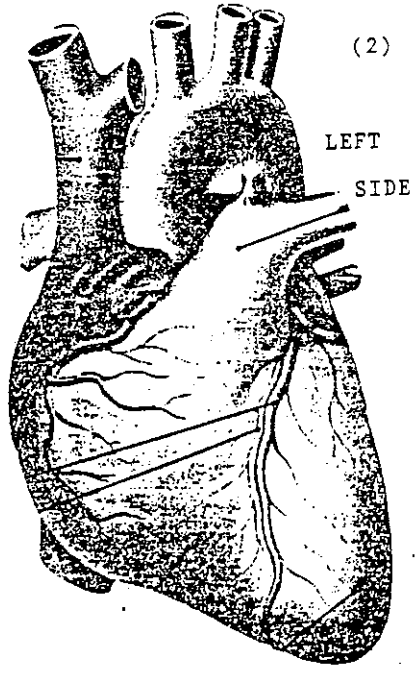

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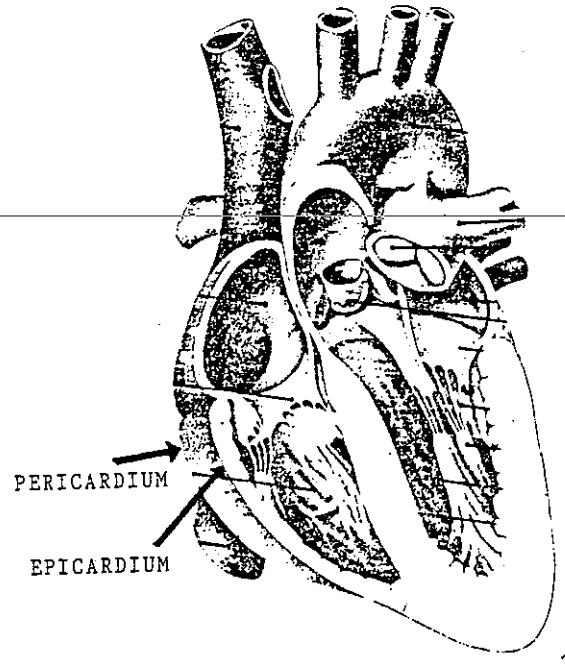

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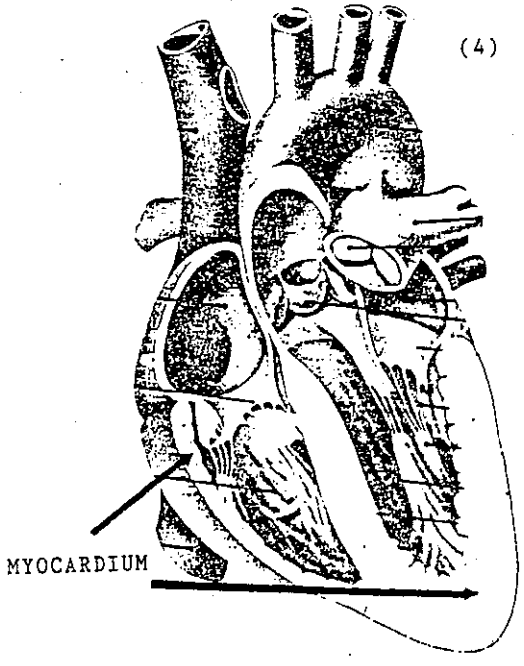

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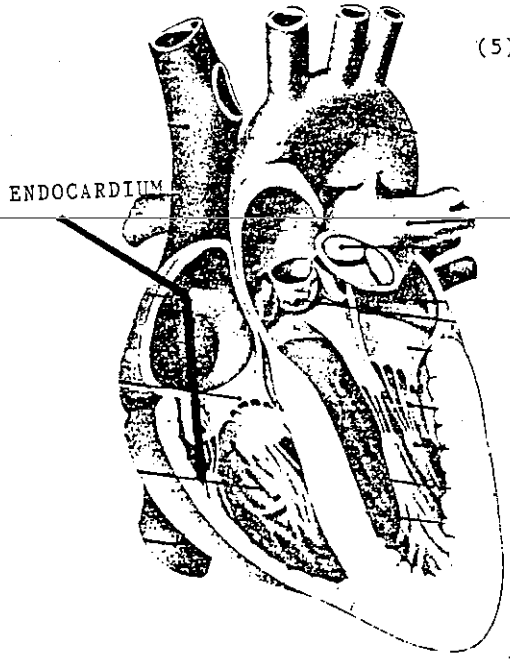

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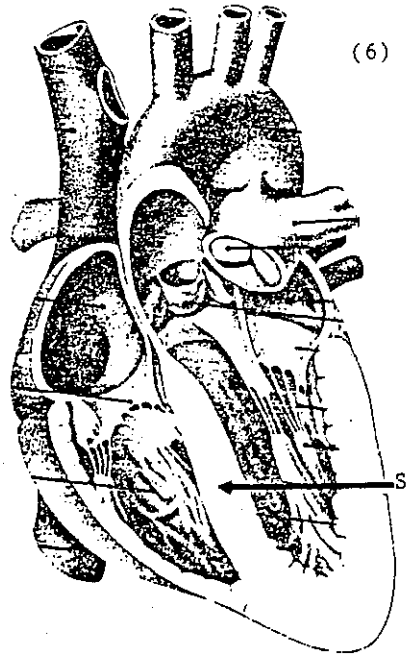

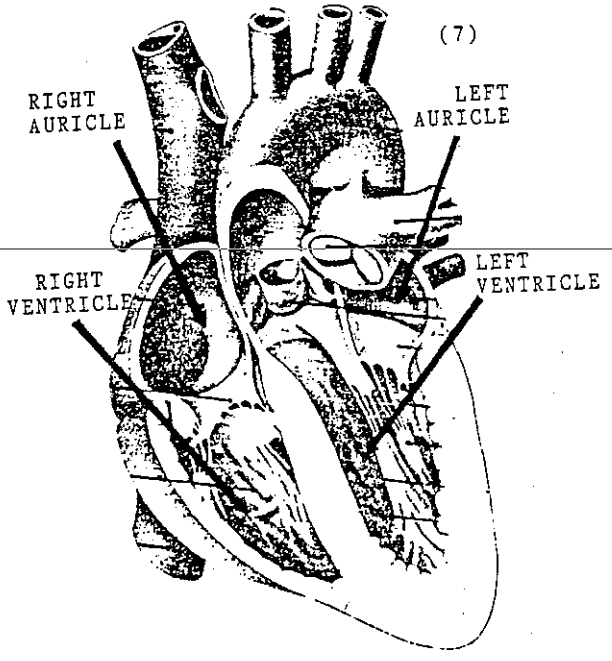
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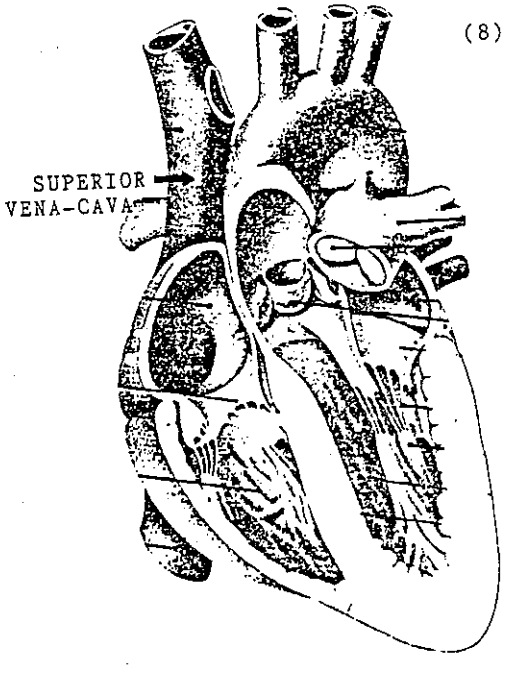
LEFT AURICLE
RIGHT VENTRICLE
LEFT VENTRICLE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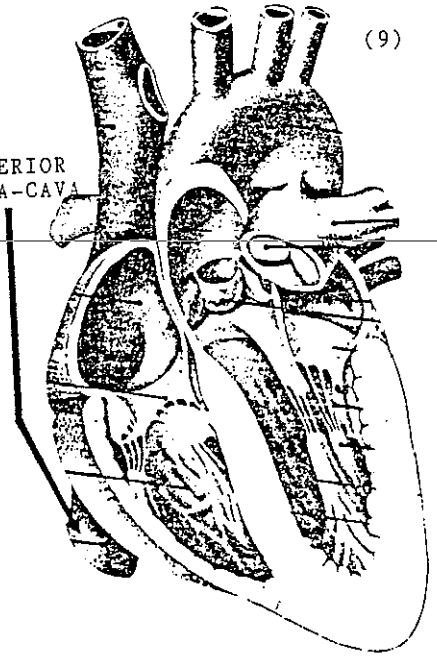
(9)



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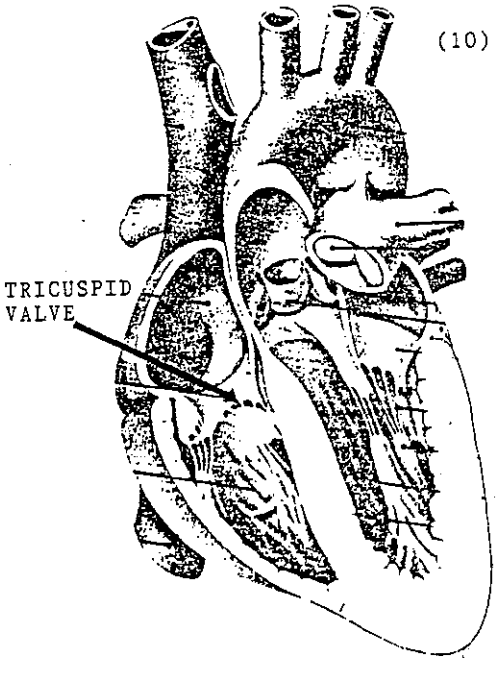

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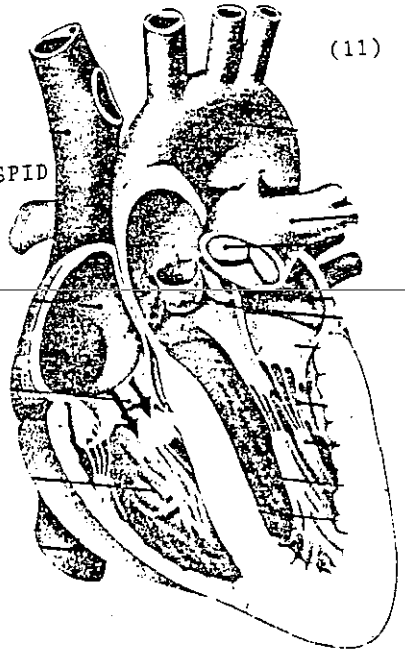

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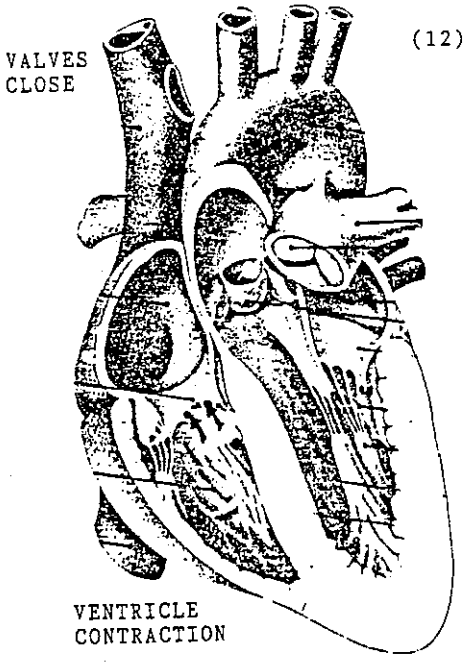

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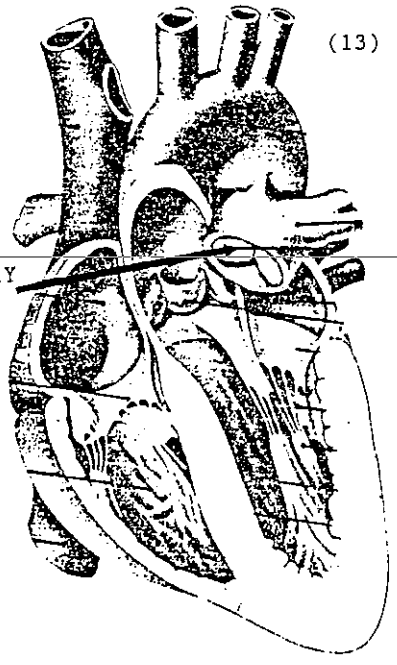

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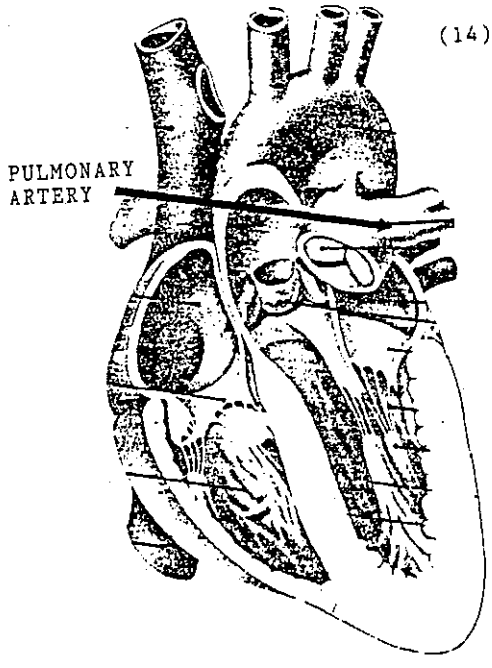

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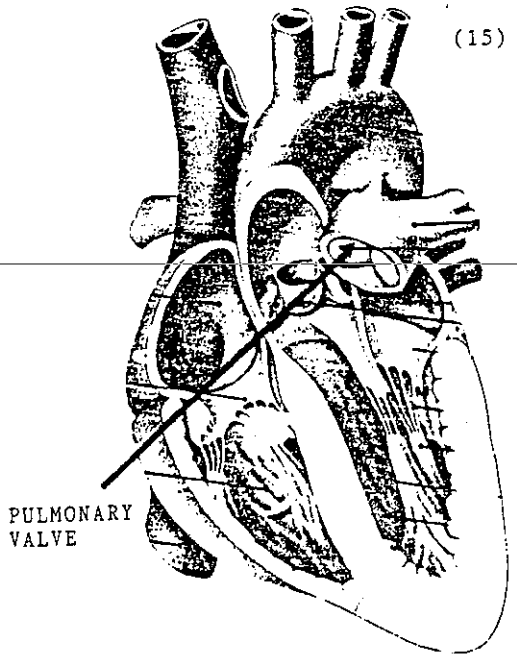

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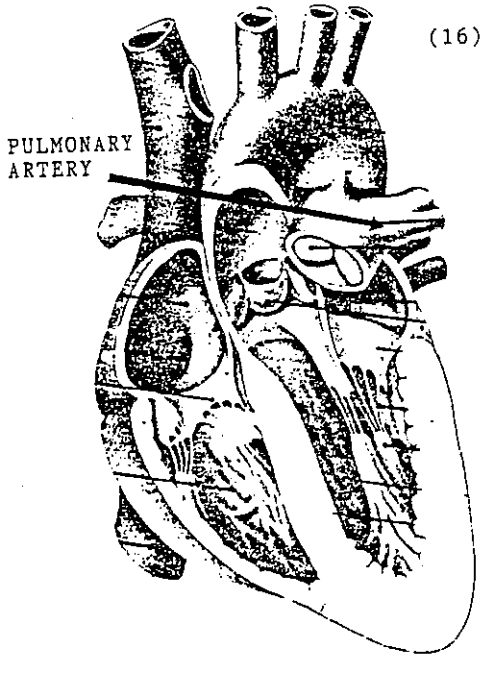

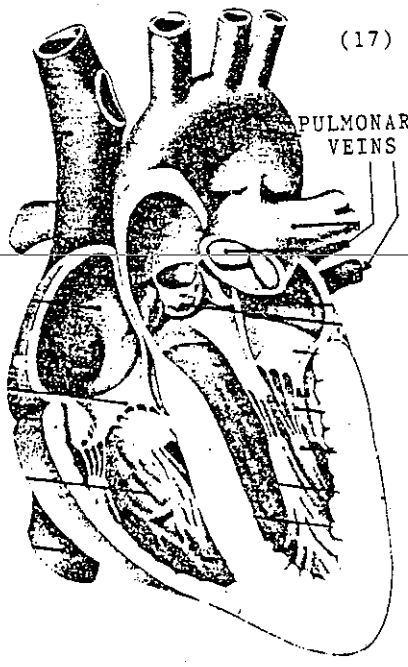
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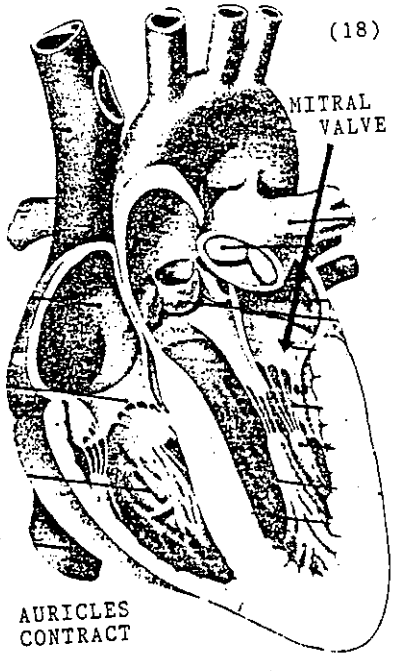
VEINS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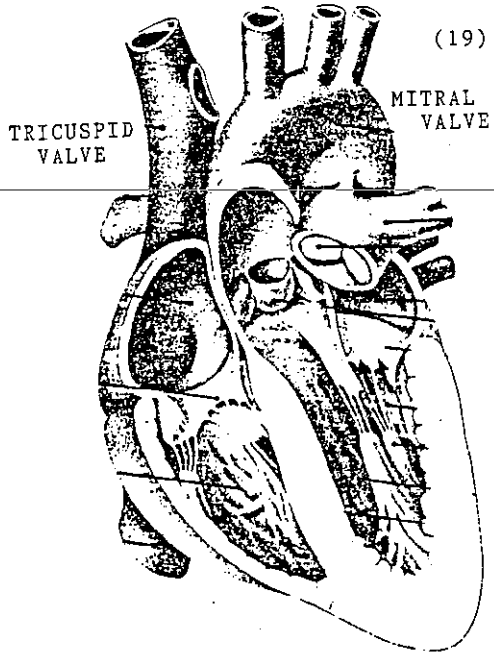
VALVE
AURICLES
CONTRACT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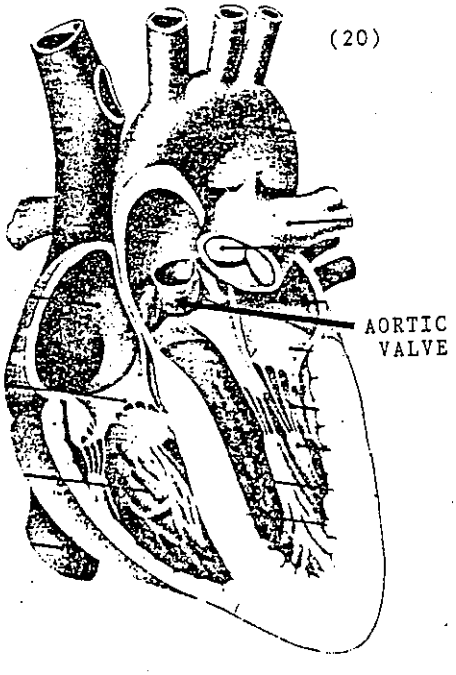
MITRAL VALVE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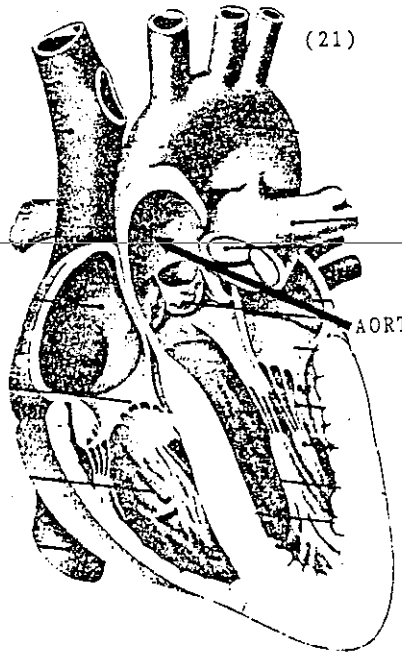

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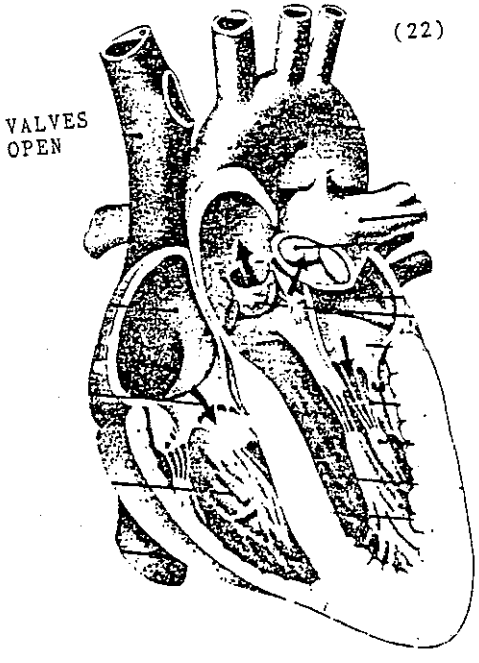

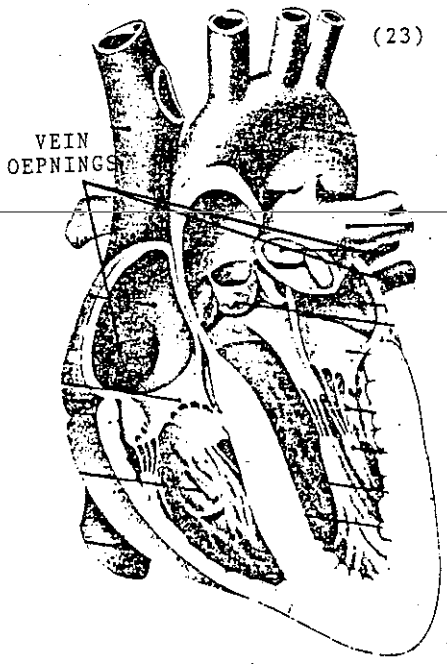
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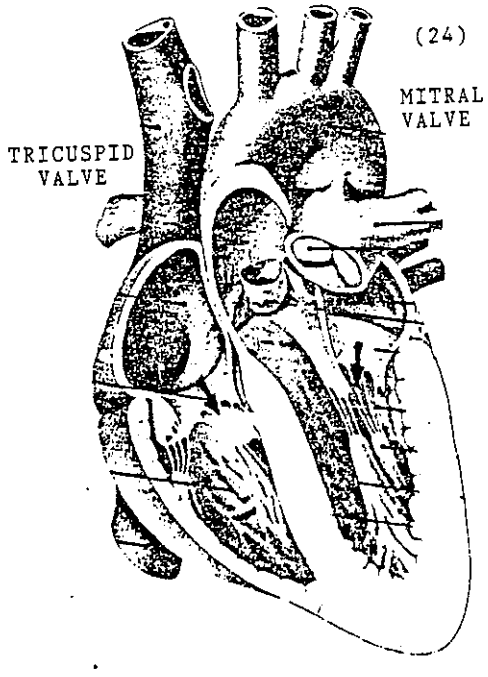
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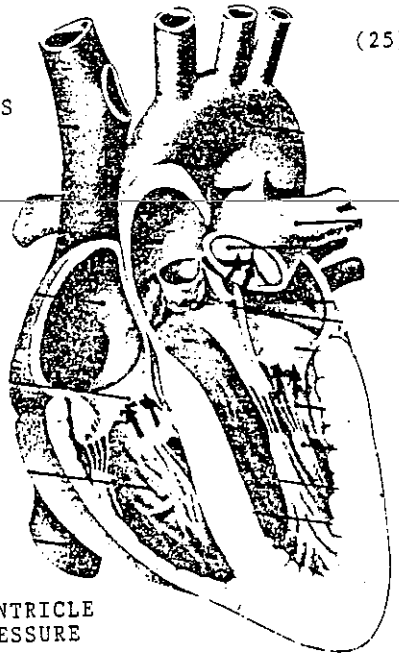
MITRAL
VALVE
TRICUSPID
VALVE

(25)

VALVES
CLOSE



VENTRICLE
PRESSURE

(26)

VALVES
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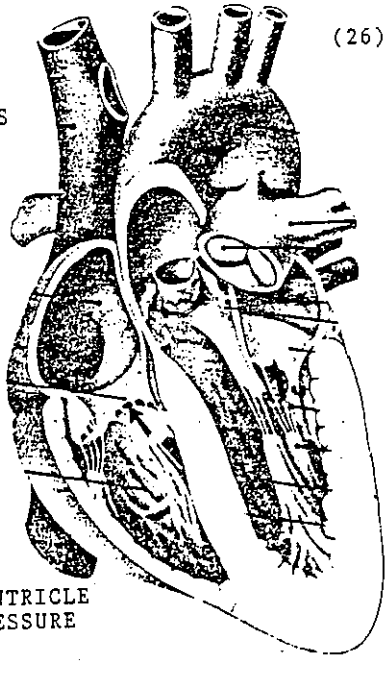


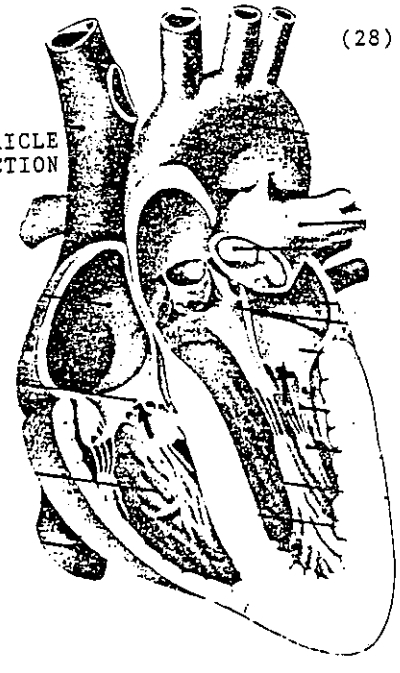
VENTRICLE
PRESSURE

(27)

VEIN
OPENINGS

(28)

VENTRICLE
CONTRACTION



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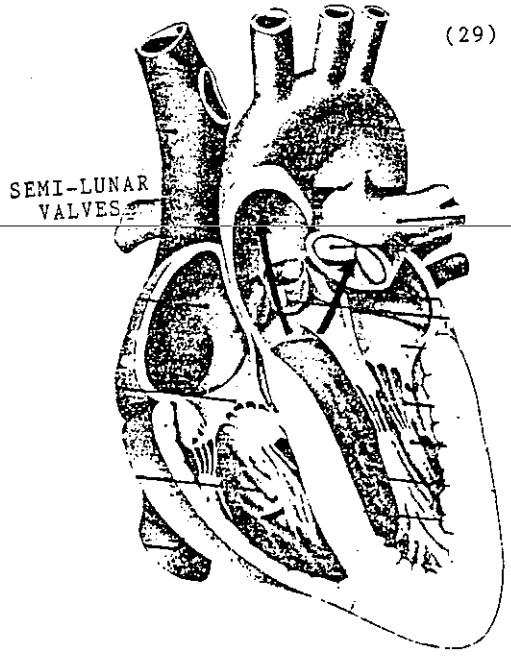

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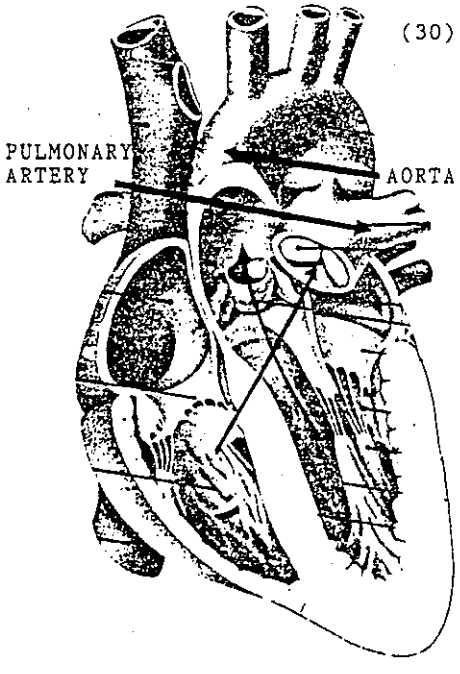

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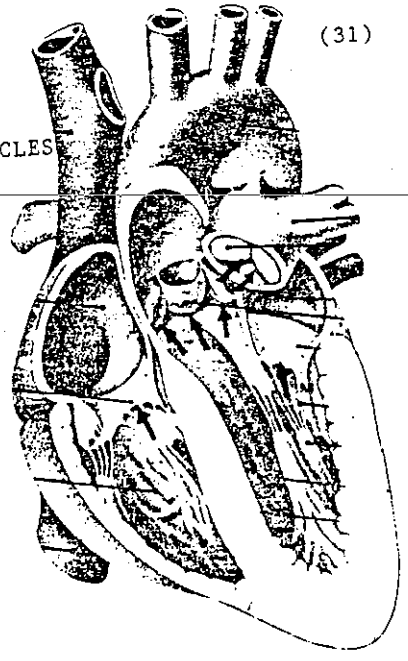

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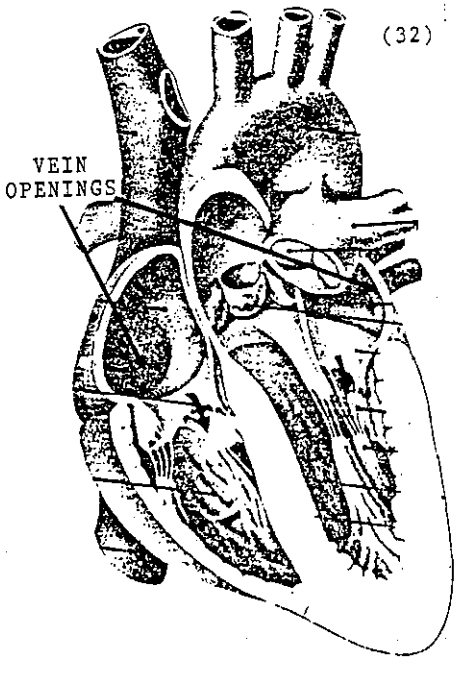

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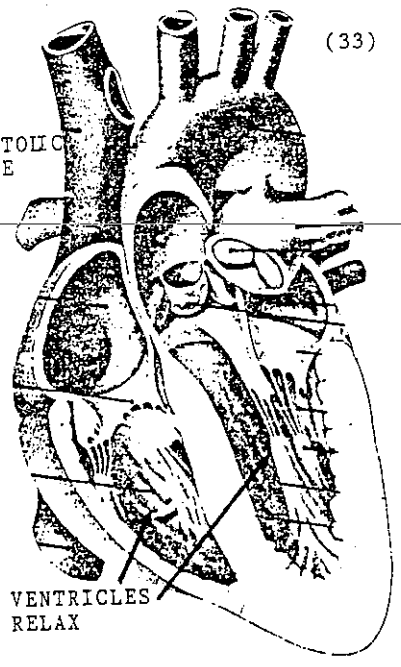
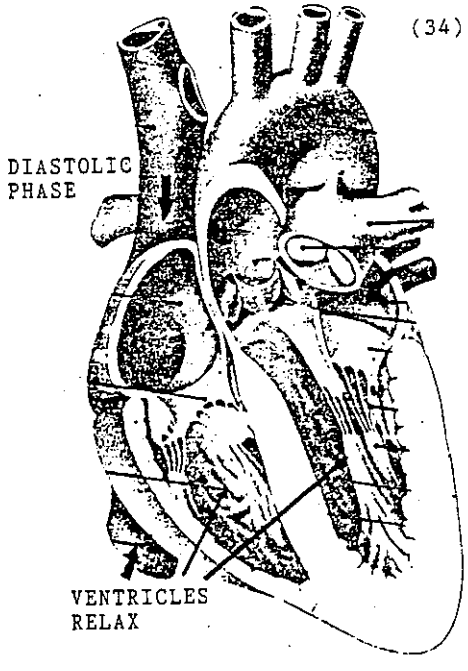

DIASTOLIC
PHASE
VENTRICLES
RELAX

(34)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PHASE
VENTRICLES
RELAX

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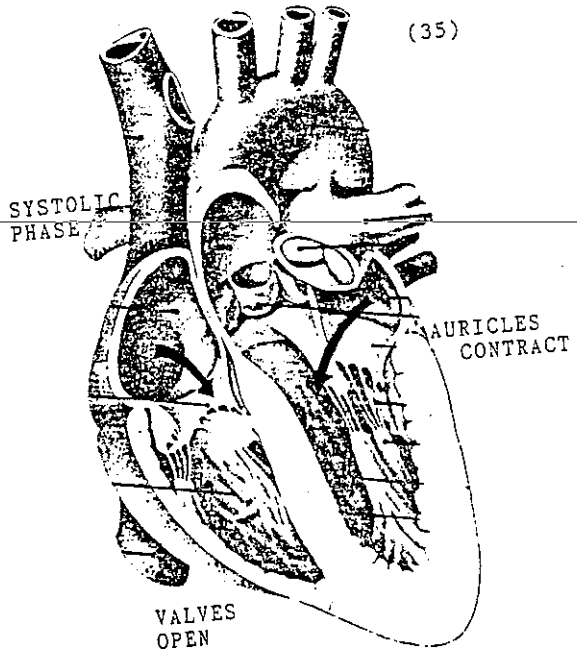
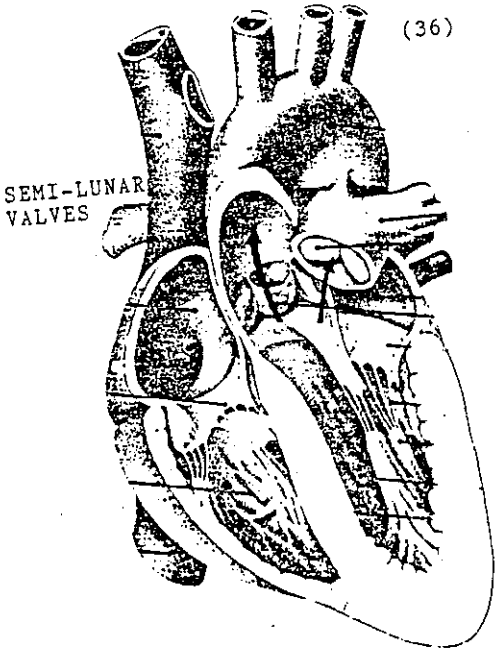
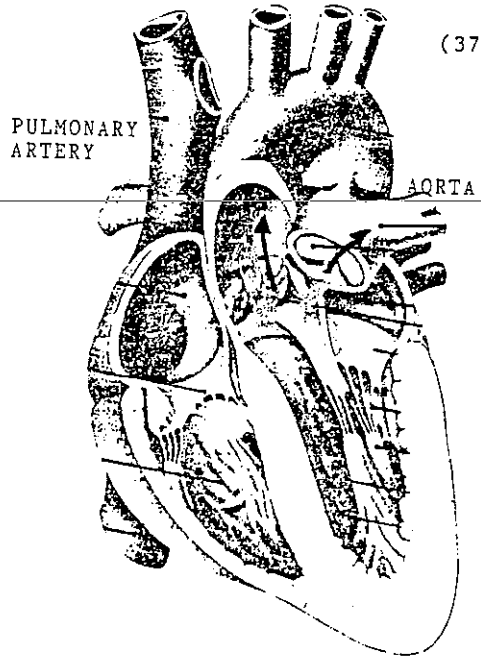

SYSTOLIC
PHASE
AURICLES
CONTRACT
VALVES
OPEN

(36)


SEMI-LUNAR
VALVES

(37)



Appendix C

Introductory Statements on

Preconceived Degree of Difficulty

Instructional Material

Directions: This instructional booklet describes the parts of the human heart and its internal processes. Do not turn to the next page unless you are told to do so. Read the material carefully. Remember, you may read the material only ONCE. DO NOT REREAD A PAGE AND DO NOT GO BACK TO PAGES YOU HAVE ALREADY READ.

NOTE: This material you are about to read is classified as VERY EASY for COLLEGE FRESHMEN. This means that this material can easily be understood and remembered.

* * * *

Instructional Material

Directions: This instructional booklet describes the parts of the human heart and its internal processes. Do not turn to the next page unless you are told to do so. Read the material carefully. Remember, you may read the material only ONCE. DO NOT REREAD A PAGE AND DO NOT GO BACK TO PAGES YOU HAVE ALREADY READ.

NOTE: This material you are about to read is classified as AVERAGE in difficulty for TYPICAL COLLEGE STUDENTS. This means that this material can easily be understood or remembered.

* * * *

Instructional Material

Directions: This instructional booklet describes the parts of the human heart and its internal processes. Do not turn to the next page unless you are told to do so. Read the material carefully. Remember, you may read the material only ONCE. DO NOT REREAD A PAGE AND DO NOT GO BACK TO PAGES YOU HAVE ALREADY READ.

NOTE: This material you are about to read is classified as VERY DIFFICULT for COLLEGE SENIORS. This means that this material can easily be understood or remembered. Careful attention and concentration is extremely necessary.

* * * *

Appendix D

Validity Assessment Scale for Preconceived Degree of Difficulty

Immediate Assessment

Name: _____ Date: _____

Sex: M F

Please answer the following question:

Before proceeding with the session, how difficult do you think the instructional material will be?

1	2	3	4	5
Very Easy	Easy	Average	Difficult	Very Difficult

Delayed Assessment

Name: _____ Date: _____

Sex: M F

Please answer the following question:

Now that you have been presented the instructional material and have taken the tests, how would you rate the level of difficulty of the instructional material?

1	2	3	4	5
Very Easy	Easy	Average	Difficult	Very Difficult

Appendix E

Answer Sheets

Name:_____
Date:_____
Sex: M F

ANSWER SHEET NO. 1

Part One

Drawing Test

Name:_____
Date:_____
Sex: M F

ANSWER SHEET NO. 2

Part Two

Identification Test

1.	a	b	c	d	e	11.	a	b	c	d	e
2.	a	b	c	d	e	12.	a	b	c	d	e
3.	a	b	c	d	e	13.	a	b	c	d	e
4.	a	b	c	d	e	14.	a	b	c	d	e
5.	a	b	c	d	e	15.	a	b	c	d	e
6.	a	b	c	d	e	16.	a	b	c	d	e
7.	a	b	c	d	e	17.	a	b	c	d	e
8.	a	b	c	d	e	18.	a	b	c	d	e
9.	a	b	c	d	e	19.	a	b	c	d	e
10.	a	b	c	d	e	20.	a	b	c	d	e

Name:_____
Date:_____
Sex: M F

ANSWER SHEET NO. 3

Part Three

Terminology Test

1.	a	b	c	d	e	11.	
2.	a	b	c	d	e	12.	
3.	a	b	c	d	e	13.	
4.	a	b	c	d	e	14.	
5.	a	b	c	d	e	15.	
6.	a	b	c	d	e	16.	
7.	a	b	c	d	e	17.	
8.	a	b	c	d	e	18.	
9.	a	b	c	d	e	19.	
10.	a	b	c	d	e	20.	

Name:_____
Date:_____
Sex: M F

ANSWER SHEET NO. 4

Part Four

Comprehension Test

1.	a	b	c	d	e	11.
2.	a	b	c	d	e	12.
3.	a	b	c	d	e	13.
4.	a	b	c	d	e	14.
5.	a	b	c	d	e	15.
6.	a	b	c	d	e	16.
7.	a	b	c	d	e	17.
8.	a	b	c	d	e	18.
9.	a	b	c	d	e	19.
10.	a	b	c	d	e	20.

Appendix F

Part One

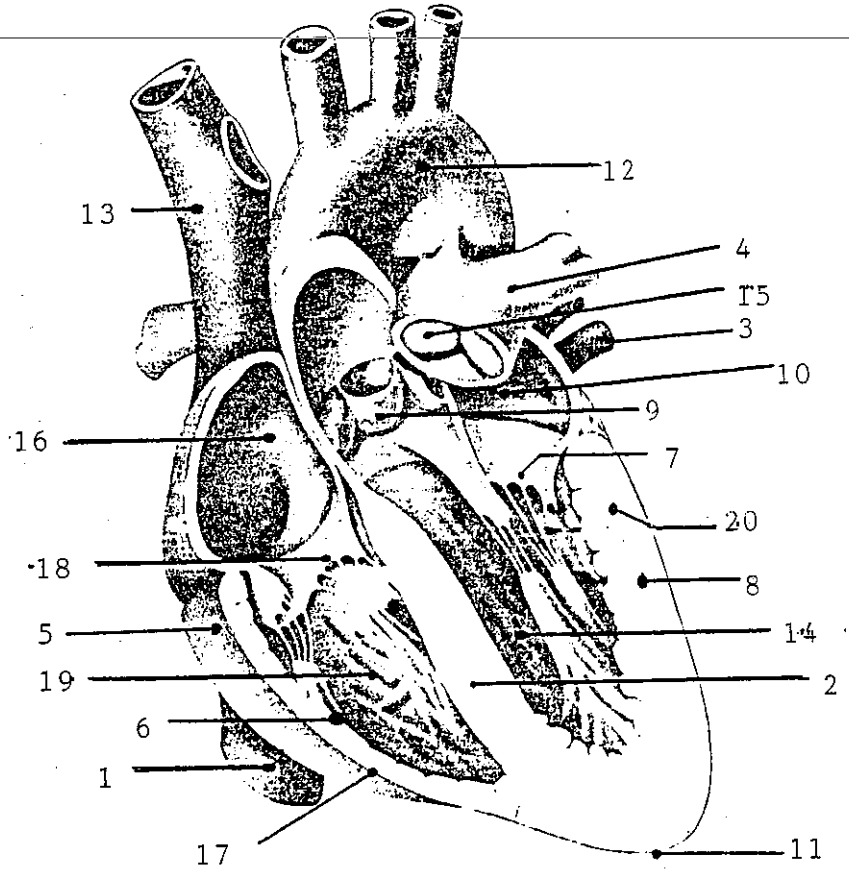
Drawing Test

Draw a picture of a heart and place the number of the identified parts where they would be located on the heart. Use the answer sheet provided.

1. superior vena cava
2. aorta
3. tricuspid valve
4. pulmonary vein
5. septum
6. epicardium
7. aortic valve
8. pulmonary valve
9. inferior vena cava
10. pulmonary artery
11. myocardium
12. endocardium
13. mitral valve
14. right auricle
15. right ventricle
16. left auricle
17. left ventricle
18. apex

Part Two

Identification Test



Identification test

Select the answer you feel best identifies the part of the heart indicated by the numbered arrows and mark the corresponding letter on the provided answer sheet.

1. Arrow number one (1) points to the
   a. aorta
   b. mitral valve
   c. superior vena cava opening
   d. inferior vena cava opening
   e. septum

2. Arrow number two (2) points to the
   a. pericardium
   b. endocardium
   c. septum
   d. myocardium
   e. pulmonary artery

3. Arrow number three (3) points to the
   a. inferior vena cava openings
   b. superior vena cava openings
   c. aortas
   d. pulmonary veins
   e. pulmonary arteries

4. Arrow number four (4) points to the
   a. pulmonary vein
   b. pulmonary artery
   c. aorta
   d. tricuspid valve
   e. mitral valve

5 Arrow number five (5) points to the
   a. myocardium
   b. ectoderm
   c. pericardium
   d. endocardium
   e. aortic base

6. Arrow number six (6) points to the
   a. endocardium
   b. myocardium
   c. pericardium
   d. muscle
   e. septum

Identification test

7. Arrow number seven (7) points to the
   a. venic valve
   b. pulmonary valve
   c. tricuspid valve
   d. mitral valve
   e. aortic valve

8. Arrow number eight (8) points to the
   a. pericardium
   b. endocardium
   c. ectrocardium
   d. ectodern
   e. myocardium

9. Arrow number nine (9) points to the
   a. superior vena cava opening
   b. inferior vena cava opening
   c. aortic valve
   d. pulmonary valve
   e. mitral valve

10. Arrow number ten (10) points to the
    a. right auricle
    b. right ventricle
    c. left auricle
    d. left ventricle
    e. pulmonary artery

11. Arrow number eleven (11) points to the
    a. pericardium
    b. myocardium
    c. endocardium
    d. endoderm
    e. apex

12. Arrow number twelve (12) points to the
    a. septum
    b. aorta
    c. pulmonary artery
    d. pulmonary veins
    e. none of these

13. Arrow number thirteen (13) points to the
    a. superior vena cava opening
    b. right auricle
    c. mitral valve
    d. tricuspid valve
    e. none of these

Identification test

14. Arrow number fourteen (14) points to the
    a. right ventricle
    b. left ventricle
    c. left auricle
    d. right auricle
    e. pericardium

15. Arrow number fifteen (15) points to the
    a. pulmonary vein
    b. aorta
    c. pulmonary valve
    d. right auricle
    e. aortic valve

16. Arrow number sixteen (16) points to the
    a. right ventricle
    b. right auricle
    c. left ventricle
    d. left auricle
    e. epicardium

17. Arrow number seventeen (17) points to the
    a. epicardium
    b. pericardium
    c. endocardium
    d. myocardium
    e. none of these

18. Arrow number eighteen (18) points to the
    a. aortic valve
    b. pulmonary valve
    c. mitral valve
    d. tricuspid valve
    e. septic valve

19. Arrow number nineteen (19) points to the
    a. left ventricle
    b. right ventricle
    c. right auricle
    d. left auricle
    e. vascular space

20. Arrow number twenty (20) points to the
    a. myocardium
    b. endocardium
    c. ectocardium
    d. epicardium
    e. none of these

Part Three

Terminology test

1. Blood from the right ventricle leaves the heart through the _____.
   a. veins
   b. aortic artery
   c. pulmonary artery
   d. pulmonary veins
   e. superior vena cava

2. The _____ is (are) the strongest section(s) of the heart.
   a. left ventricle
   b. aorta
   c. septum
   d. pulmonary veins
   e. tendons

3. When blood returns to the heart from the lungs, it enters the _____.
   a. right auricle
   b. pulmonary veins
   c. left auricle
   d. right ventricle
   e. pulmonary artery

4. Vessels that allow the blood to flow from the heart are called _____.
   a. veins
   b. arteries
   c. apex
   d. tendons
   e. flaps

5. Blood passes from the left ventricle out the aortic valve to the _____.
   a. lungs
   b. body
   c. aorta
   d. pulmonary artery
   e. left auricle

6. Deoxygenated blood enters the heart through the _____.
   a. aortic artery
   b. pulmonary veins
   c. pulmonary artery
   d. superior and inferior vena cavas
   e. superior vena cava only

Terminology test

7. The _____ allow(s) blood to travel in one direction only.
   a. septum
   b. valves
   c. arteries
   d. veins
   e. tendons

8. The _____ is located between the left auricle and the left ventricle.
   a. aortic valve
   b. pulmonary valve
   c. septum
   d. tricuspid valve
   e. mitral valve

9. The semi-lunar valves are the valves having triangular flaps and are located on the _____.
   a. pulmonary veins
   b. superior and inferior vena cavas
   c. pulmonary and aortic arteries
   d. mitral and tricuspid structures
   e. pulmonary artery and veins

10. Immediately before entering the aorta, blood must pass through the _____.
    a. left ventricle
    b. mitral valve
    c. lungs
    d. superior vena cava
    e. aortic valve

11. _____ (are) the thick walled chamber(s) of the heart.

12. The heartbeat consists of two parts; the contraction of the ventricles is called the _____ phase.

13. The relaxation of the ventricles is called the _____ phase.

14. The chamber of the heart which pumps oxygenated blood to all parts of the body is the _____.

15. The _____ is another name for the part of the heart called the heart muscle.

Terminology test

16. _____ is (are) the part of the heart which controls its contraction and relaxation.

17. The _____ is the name given to the inside lining of the heart wall.

18. The tissue which protects the inside lining of the pericardium is called the _____.

19. The _____ is the passage between the right auricle and the right ventricle.

20. The outside covering of the heart is called the _____.

Part Four

Comprehension test

1. The contraction impulse in the heart starts in
   a. the septum
   b. both ventricles simultaneously
   c. both auricles simultaneously
   d. the arteries

2. In the diastolic phase, the ventricles are
   a. fully contracted
   b. partially contracted
   c. fully relaxed
   d. partially relaxed

3. During the systolic phase, blood is being forced through the
   a. pulmonary and aortic arteries
   b. superior and inferior vena cavas
   c. tricuspid and mitral valves
   d. pulmonary veins

4. When the heart contracts, the
   a. auricles and ventricles contract simultaneously
   b. ventricles contract first, then the auricles
   c. right side contracts first, then the left side
   d. auricles contract first, then the ventricles

5. Which one of the following statements is false? When the auricles contract, blood is forced out of the
   a. superior and inferior vena cavas
   b. pulmonary veins
   c. tricuspid and mitral valves
   d. aortic and pulmonary valves

6. When the mitral and tricuspid valves are forced shut, in what position is the pulmonary valve?
   a. closed
   b. partially open
   c. open
   d. partially closed

7. During the systolic phase, in what position is the aortic valve?
   a. fully open
   b. partially open
   c. partially closed
   d. fully closed

Comprehension Test

8. Blood is being forced out the pulmonary veins simultaneously as blood is
   a. entering the vena cavas
   b. being forced out of the aortic and pulmonary valves
   c. passing through the mitral and tricuspid valves
   d. being forced through the pulmonary artery

9. If the aortic valve is completely closed, which of the following statements is correct?
   a. the systolic phase of the heart is occuring
   b. the diastolic phase of the heart is occuring
   c. the mitral and tricuspid valves are completely shut
   d. the blood is rushing into the right and left auricles

10. When the heart relaxes, the
   a. auricles relax first, then the ventricles
   b. right side relaxes first, then the left side
   b. left side relaxes first, then the right side
   d. ventricles relax first, then the auricles

11. Which valve is most like the tricuspid in function?

12. When blood is being forced out the right ventricle, in what position is the tricuspid valve?

13. When the blood is being forced out of the aorta, it is also being forced out of the _____.

14. During the systolic phase, in what position will the mitral valve be?

15. When blood is entering through the vena cavas, it is also entering through the _____.

16. While impure blood is entering the superior vena cava, it is also entering the _____.

17. When blood leaves the heart through the aorta, it is also simultaneously leaving the heart through the _____.

18. When the pressure in the right ventricle is superior to that in the pulmonary artery, in what position is the tricuspid valve?

19. Blood leaving the heart through the aorta had left the heart previously through the _____.

20. When the blood in the aorta is exerting a superior pressure on the aortic valve, what is the position of the mitral valve?

Appendix G

Letter of Permission to Concerned Faculty

January 18, 1988

To Dr. Esther Cohen,

I am presently in the process of looking for participants for my Master's Thesis focusing on the effect of instructional mode of presentation and preconceived degree of difficulty on memory. Instructional mode will be in the form of written passages, diagrams, and audio recordings. Preconceived degree of difficulty, on the other hand, will vary according to each student's preconception of the relative difficulty of the memory task.

In order to complete my research, a minimum of 90 students are needed. The students will be expected to participate in two 1-hour groupsessions. I am thereby asking for your cooperation in recruiting participants from your Behavior Change I class this semester. My assistant or I will be in touch with you as to a convenient time in which we could speak to your class during the month of February about this opportunity for your students to participate in an actual research project. As an incentive for your students to participate, you might consider some type of class credit for them.

Thank you very much.

Sincerely,

Richard Velayo

Noted:

Ken Beauchamp
Thesis Chair

Appendix H

Script for Experimenter

Audio-only Condition.

Hi, my name is Richard. I want to thank all of you for coming. Before I proceed, I would like to remind you that we will also be meeting next week at this same time and place for additional testing (give them a written memo for next week's meeting). If this is a problem, talk to me after you are done with today's testing.

The research I am doing concerns memory. Research studies have been done regarding how effective instructions are in the form of audio recordings. The findings in these studies indicate that. . .

(1) VERY EASY condition: for college freshmen, the material you are about to listen to has been classified as VERY EASY.

(2) NEUTRAL condition: for the typical college student, the material you are about to listen to has been classified as AVERAGE IN DIFFICULTY.

(3) VERY DIFFICULT condition: for college seniors, the material you are about to listen to has been classified as EXTREMELY DIFFICULT.

When the testing begins, you will be listening to the audio tape using the tape recorder and headphones you are provided with. Once you have started, you are not allowed to rewind the tape for any reason, so please listen to the tape very carefully and try to remember everything you can from what you have heard. When you have finished listening to the tape once, raise your hand so I can give you the first of four tests. Each test will be given separately, so you need to finish a test before I give you the next one. The purpose of the tests is to evaluate how much you remember of the material you heard. Do your best in answering the test questions and you may take your time in answering them. All of your test scores will be held confidential and will only be revealed to you, if you wish, approximately 4 weeks from today. Remember, you are allowed to listen to the tape once. Do not rewind or listen again to the tape.

Before we begin, has anyone taken college courses in anatomy or physiology or believes himself to be very knowledgeable about the parts and functions of the human heart? (Mark an "X" on the answer sheets of participants have.)

Do you have any questions before we proceed?

(Distribute and collect introductory statement.)

(Distribute instructional material and explain directions.)

(Proceed with presentation of material; then administer each tect separately.)

(Remind students of their next session.)

Pictorial ± audio, print ± audio, pictorial ± print ± audio Conditions.

Hi, my name is Richard. I want to thank all of you for coming. Before I proceed, I would like to remind you that we will also be meeting next week at this same time and place for additional testing (give them a written memo for next week's meeting). If this is a problem, talk to me after you are done with today's testing.

The research I am doing concerns memory. Research studies have been done regarding this material and the tests that will follow. The findings in these studies indicate that. . .

(1) VERY EASY condition: for college freshmen, this material has been classified as VERY EASY.

(2) NEUTRAL condition: for the typical college student, this material has been classified as AVERAGE IN DIFFICULTY.

(3) VERY DIFFICULT condition: for college seniors, this material has been classified as EXTREMELY DIFFICULT.

When the testing begins, you will be listening to the audio tape using the tape recorder and headphones you are provided with. Please keep pace with the tape in looking at your instructional booklets. Once you have started, you are not allowed to rewind the tape for any reason, so please listen to the tape very carefully and try to remember everything you can from what you have heard. When you have finished listening to the tape once, raise your hand so I can give you the first of four tests. Each test will be given separately, so you need to finish a test before I give you the next one. The purpose of the tests is to evaluate how much you remember of the material. Do your best in answering the test questions and you may take your time in answering them. All of your test scores will be held confidential and will only be revealed to you, if you wish, approximately 4 weeks from today. Remember, you are allowed to listen to the tape once. Do not rewind or listen again to the tape.

Before we begin, has anyone taken college courses in anatomy or physiology or believes himself to be very knowledgeable about the parts and functions of the

human heart? (Mark an "X" on the answer sheets of participants have.)

Do you have any questions before we proceed?

(Distribute and collect introductory statement.)

(Distribute instructional material and explain directions.)

(Proceed with presentation of material; then administer each test separately.)

(Remind students of their next session.)

Pictorial + print and print-only Condition.

Hi, my name is Richard. I want to thank all of you for coming. Before I proceed, I would like to remind you that we will also be meeting next week at this same time and place for additional testing (give them a written memo for next week's meeting). If this is a problem, talk to me after you are done with today's testing.

The research I am doing concerns memory. Research studies have been done regarding this material and the tests that will follow. The findings in these studies indicate that. . .

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VERY EASY.

(2) NEUTRAL condition: for the typical college student, the material you are about to read has been classified as AVERAGE IN DIFFICULTY.

(3) VERY DIFFICULT condition: for college seniors, the material you are about to read has been classified as EXTREMELY DIFFICULT.

Start reading the material only when I signal you to do so. Once you have started, you are not allowed to reread or go back to pages you have already read, so please read the material very carefully and try to remember everything you can from what you have read. When you have finished reading the material once, raise your hand so I can give you the first of four tests. Each test will be given separately, so you need to finish a test before I give you the next one. The purpose of the tests is to evaluate how much you remember of the material you read. Do your best in answering the test questions and you may take your time in answering them. All of your test scores will be held confidential and will only be revealed to you, if you wish, approximately 4 weeks from today. Remember, you are allowed to read the material only once. Do not reread or go back to those pages you have already read.

Before we begin, has anyone taken college courses in anatomy or physiology or believes himself to be very knowledgeable about the parts and functions of the human heart? (Mark an "X" on the answer sheets of participants have.)

Do you have any questions before we proceed?

(Distribute and collect introductory statement.)

(Distribute instructional material and explain directions.)

(Proceed with presenation of material; then administer each test separately.)

(Remind students of their next session.)